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DEPARTMENT OF THE ARMY TECHNICAL MANUAL

DEPARTMENT OF THE AIR FORCE TECHNICAL ORDER

TM 11-5092

TO 16-35R394-5

1- Rec. 143.99 = 22,698.33 KH.
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13 DEC 65

RADIO RECEIVER

R-394/U

national 2 meter frequency
146.94

K4OG/WB4RNH
CHES. WATKINS
P. O. BOX 3268
FT. PIERCE, FLA. 33450

DEPARTMENTS OF THE ARMY AND THE AIR FORCE
NOVEMBER 1954

AGO 1774A—Oct

WARNING

HIGH VOLTAGE

is used in the operation
of this equipment.

DEATH ON CONTACT

may result if personnel fail
to observe safety precautions.

TECHNICAL MANUAL
No. 11–5092
TECHNICAL ORDER
No. 16–35R394–5

DEPARTMENTS OF THE ARMY AND
THE AIR FORCE

WASHINGTON 25, D. C., *24 November 1954*

RADIO RECEIVER R–394/U

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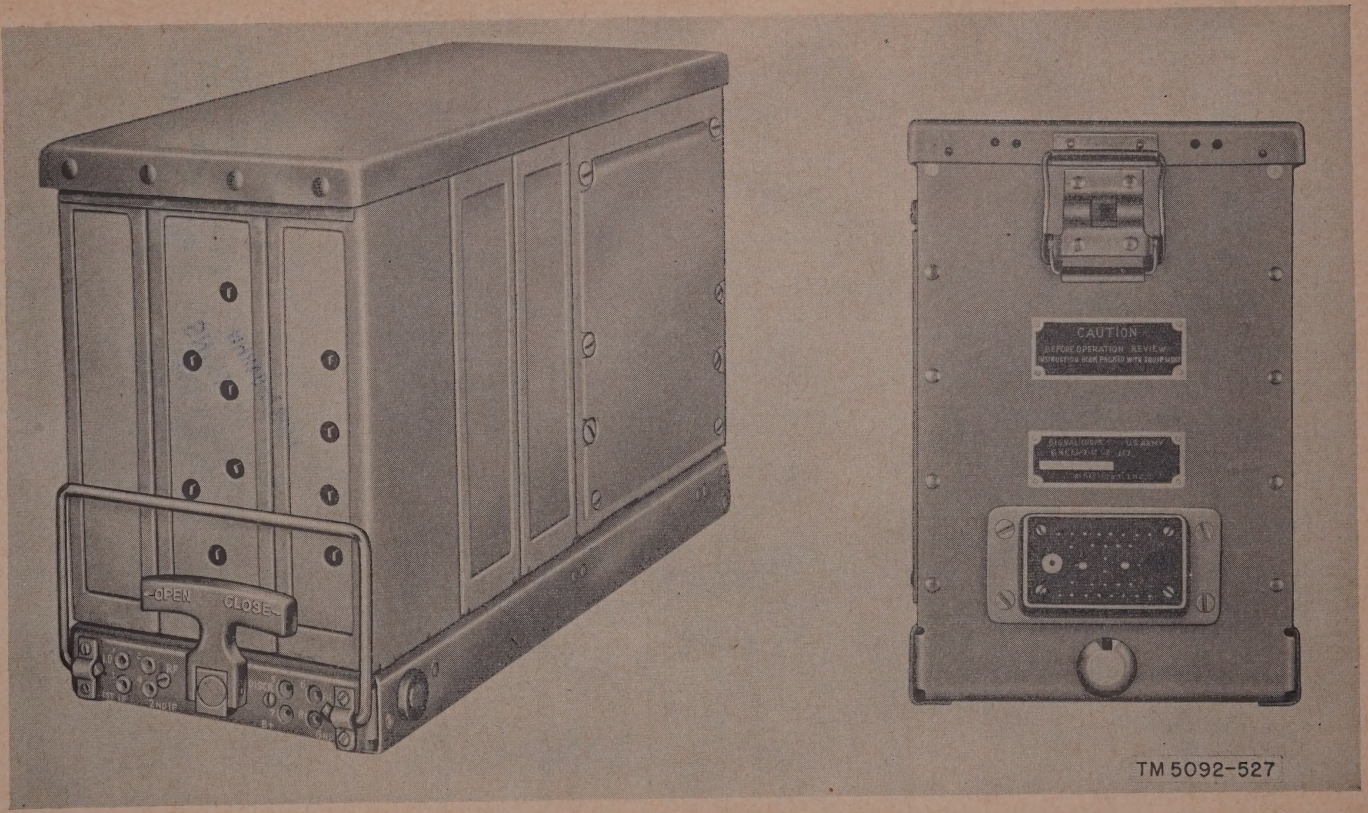

Figure 1. Radio Receiver R–394/U, front and rear.

CHAPTER 1

INTRODUCTION

Section I. GENERAL

1. Scope

This manual contains the necessary instructions for the installation, operation, maintenance, and repair of Radio Receiver R–394/U (fig. 1). Theory is also included so that the repairman will have a better understanding of the radio receiver.

2. Forms and Records

The following forms will be used for reporting unsatisfactory conditions of Army materiel and equipment.

a. DD Form 6, Report of Damaged or Improper Shipment, will be filled out and forwarded as prescribed in SR 745–45–5 (Army), Navy Shipping Guide, Article 1850–4, (Navy), and AFR 71–4 (Air Force).

b. DA Form 468, Unsatisfactory Equipment Report, will be filled out and forwarded to the Office of the Chief Signal Officer as prescribed in SR 70–45–5.

c. DD Form 535, Unsatisfactory Report, will be filled out and forwarded as prescribed in SR 700–45–5 and AFR 65–26.

d. DA Form 11–239, Second and Third Echelon Maintenance Checklist for Signal Corps Equipment (Radio Communication, Direction Finding, Carrier, Radar), will be prepared in accordance with instructions on the back of the form (fig. 16).

e. Use other forms and records as authorized.

Section II. DESCRIPTION AND DATA

3. Purpose and Use

Radio Receiver R–394/U is a 22-tube double conversion superheterodyne receiver. It operates in the frequency range of 152 to 174 megacycles (mc) at a crystal controlled preset frequency. The design is such that it must be used with additional equipment because it does not have controls or a reproduction unit for converting the audio output signals to sound waves.

a. The receiver is used for detecting frequency-modulated (fm) signals and converting them to usable audio signals. A relay can be added to the receiver for controlling the operation of a radio transmitter, such as Radio Transmitter T–416/GR. Spare relay contacts are available on the relay to control other equipment.

b. The receiver is a compact unit built to withstand shocks encountered in mobile use. Operation is simple and *operational* maintenance is rapid and relatively easy because plug-in type assemblies are used for all the stages. Ordinarily, a defective receiver can be repaired merely by changing one of the plug-in units. Because of the standard construction of the receiver, it may be interchanged with other receivers of the radio sets with which it will be used.

c. Automatic gain control (agc) is incorporated to compensate for variations in signal strength as well as to provide more uniform gain among different units of this receiver. In addition to the ordinary circuits of the receiver, a squelch circuit is provided to silence the receiver when no signal is being received. A squelch relay also may be used to control a radio transmitter or a call device.

4. System Application

a. General. When Radio Receiver R–394/U is combined with certain pieces of equipment, it can be used as a part of five different radio sets, Radio Receiving Set AN/FRR–36, Radio Receiving Set AN/VRR–7, Radio Set AN/VRC–19, Radio Set AN/FRC–27, and Radio Set AN/TRC–28. A block diagram showing the components of the radio sets containing transmitters is shown in figure 2. The function of Radio Receiver R–394/U in each of these radio sets is described in *b* through *f*, below.

b. Radio Receiving Set AN/FRR–36 (fig. 3). Radio Receiving Set AN/FRR–36 is the simplest of the group and is designed for single channel reception only. It consists of Radio

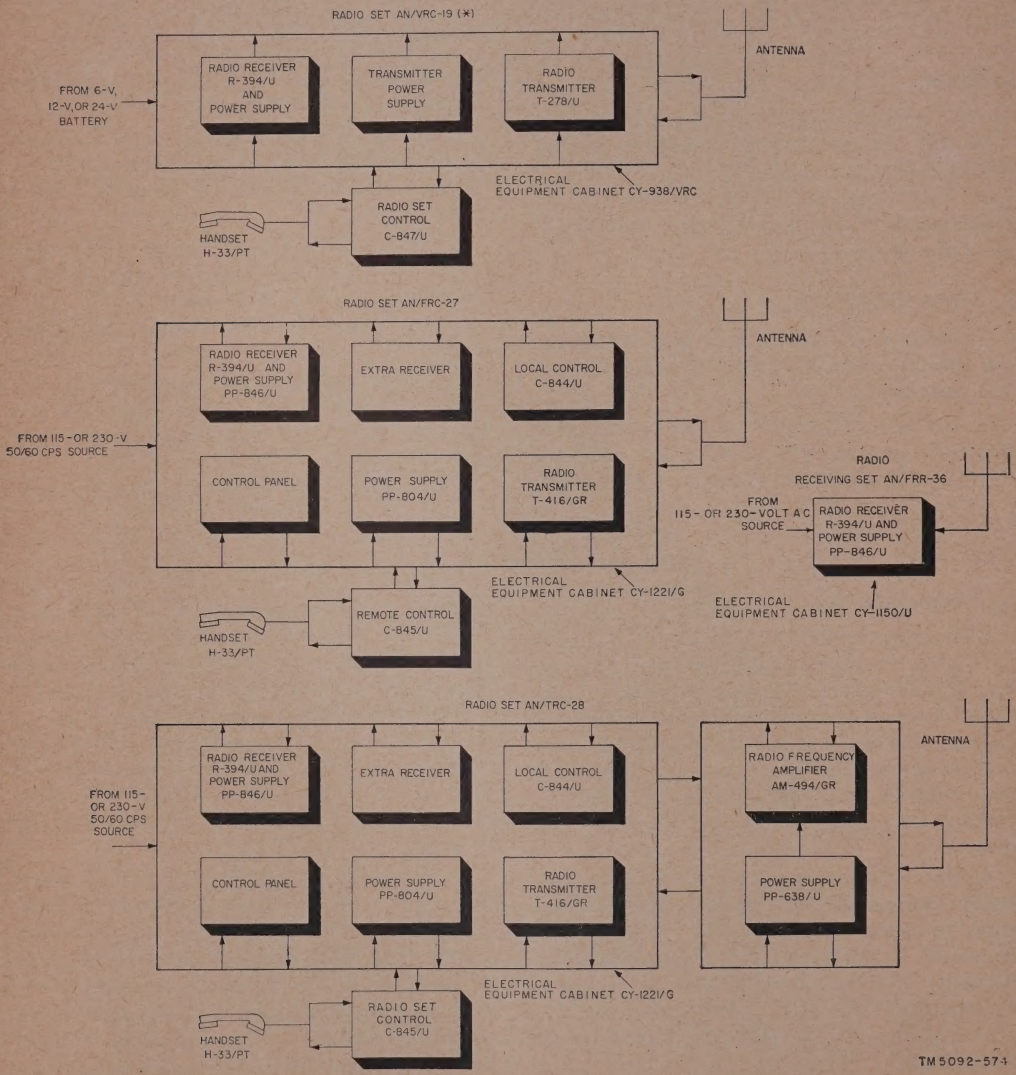

Figure 2. Radio Receiver R–394/U, system application.

Figure 3. Radio Receiving Set AN/FRR–36, less antenna and connecting cord.

Receiver R–394/U mounted in Electrical Equipment Cabinet CY–1150/U. The power source required is 115 or 230 volts at 50 to 60 cycles per second (cps), making it a fixed station set. The controls are on the front panel of the cabinet. The antenna is a vertical quarter-wave type.

c. Radio Receiving Set AN/VRR–7. Radio Receiving Set AN/VRR–7 is similar to Radio Receiving Set AN/FRR–36 except that it is used for vehicular operation and is powered by a direct-current (dc) 6-, 12-, or 24-volt power supply. The controls are on the front panel of the cabinet of the radio set. A whip antenna is used with the radio set.

d. Radio Set AN/VRC–19(*). Radio Set AN/VRC–19(*) is a mobile receiver-transmitter designed to operate in a vehicle with a 6-, 12-, or 24-volt storage battery. Radio Receiver R–394/U is interconnected in this radio set with Radio Transmitter T–278/U and its associated power supply by wiring in Electrical Equipment Cabinet CY–938/VRC. For normal use, the radio set is operated with push-to-talk control. Pressing a push-to-talk switch on a handset operates the transmitter and disables the receiver. Releasing the switch disables the transmitter and allows the receiver to operate. The receiver and transmitter may be operated simultaneously, however, for retransmission purposes. For retransmission, the audio output of the receiver is connected to the audio input of the transmitter, which transmits the signal at a different radio frequency. In effect, this retransmission process makes the radio set a mobile radio relay station. The transmitter output power is approximately 25 watts.

e. Radio Set AN/FRC–27. Radio Set AN/FRC–27 is a fixed station (receiver and transmitter) which operates from an alternat-

ing-current (ac) source of 115 or 230 volts at 50 to 60 cps. In this radio set the receiver has the same functions as in Radio Set AN/VRC–19(*). However, it is possible to use two radio receivers instead of one. This permits two-way conversation to be carried on in addition to normal push-to-talk operation. A higher power transmitter (45 watts) than that in Radio Set AN/VRC–19 is used, increasing the range slightly. The fact that the radio set is fixed makes possible the erection of higher antennas which extend the range of the set. The radio set has provision for local or remote control of the equipment.

f. Radio Set AN/TRC–28. Radio Set AN/TRC–28 consists essentially of Radio Set AN/FRC–27 plus a 250-watt radio-frequency (rf) power amplifier (Radio Frequency Amplifier AM–494/GR). The amplifier gives it a greater range than Radio Set AN/FRC–27.

5. Technical Characteristics

Frequency range	152 to 174 mc.
Receiver type	Double conversion, crystal controlled, superheterodyne, fixed frequency.
Crystal range (third overtone).	24.033 to 27.7 mc (Crystal Unit CR–32/U).
Types of signals which can be received.	Fm (± 15-kc deviation).
Number of tubes	22
Intermediate frequencies	7.8 mc and 455 kc.
Audio output impedance	8 ohms.
Audio power output	.5 watt at less than 10% distortion.
Audio frequency response.	300 to 3,500 cps ±1 *db* (without de-emphasis). 6 db per octave ±1 *db* (with de-emphasis).
Special features	Squelch and muting circuits.

Power input to radio set supplies:

Voltage source	Power supply	Input current (amperes)
6 volts dc	Power Supply PP–869/U	3.7
12 volts dc	Power Supply PP–868/U	2.0
24 volts dc	Power Supply PP–867/U	1.1
115 or 230 volts ac.	Power Supply PP–846/U	.4 at 115 volts. .2 at 230 volts.

Antenna—quarter-wave vertical
Weight—26 lb (including power supply)

6. Packaging Data

Radio Receiver R–394/U is shipped installed in the radio set case of which it is used as a component. Details of the radio set packaging will be found in the instruction book pertaining to the specific radio set. When necessary to ship Radio Receiver R–394/U separately, the packaging must keep it safe from moisture, shock, and vibration. Such packaging consists of one water-resistant carton within a second water-resistant carton. The outside container is a waterproofed wooden crate. Adequate padding must be placed between layers of the package to absorb shocks.

7. Description of Radio Receiver R–394/U

a. General. Radio Receiver R–394/U requires a plug-in power supply and an external control unit in order to operate. The power supply provides filament and B+ voltages. The control unit turns the receiver on and distributes the audio output to a handset and/or speaker. The electrical connection to the particular radio set in which it is installed is accomplished by a single connector on the rear panel. A locking handle on the front panel controls a shaft that passes through the receiver from front to rear. The rear end of this shaft is threaded to secure the receiver to the case in which it is used. A handle is provided on the front panel for pulling the receiver from the radio set case. Eight test points are provided at the front for checking the operation of the receiver and for alinement purposes. The chassis or receiver base assembly contains the following subassemblies (figs. 4 and 5):

(1) RF AMPL 152–174 MC plug-in unit.
(2) LOCAL OSC 152–174 MC plug-in unit.
(3) 1ST IF 7.8 MC plug-in unit.
(4) 2ND IF DISCR plug-in unit.
(5) AUDIO & SQUELCH plug-in unit.
(6) RELAY plug-in unit (Receiver Subassembly MX–1547/G).
(7) Selectivity filter.
(8) Power supply (par. 5).

b. Receiver Base Assembly (fig. 4). The receiver base assembly is a honey-combed assembly with eight compartments or cells into which

the eight units of the receiver are fitted. Except for selectivity filter Z251, which is wired to the receiver base, all of these units are plug-in units. These units are connected into the base when plugged into the proper compartment. The plugs and jacks on the receiver base are so arranged that the plug-in units fit only in the proper cells. The power supply is fastened to the receiver base by six screws. Power supply connector P251 is connected to the power supply from the bottom side of the receiver. A handle on this plug aids in connecting and disconnecting the plug.

c. Subassemblies. Each plug-in subassembly has a handle to remove it from the receiver base. Each unit also is shielded by a snap-on type cover which can be removed for repair or alinement.

(1) *RF AMPL 152–174 MC plug-in unit.* This unit contains three subminiature tubes; the first rf amplifier V1, the second rf amplifier V2, and the first mixer V3. Plug P2 conveys filament and B+ voltages to the unit as well as agc voltage. A test point on the front of the receiver which facilitates measuring the voltage at the control grid of the first mixer stage, V3, also is wired through this plug. Three coaxial connectors (P1, P3, and P4) are used for antenna input, LOCAL OSC 152–174 MC plug-in unit output, and first mixer output to the 7.8-mc intermediate frequency (if.) amplifier (V51) in the 1ST IF 7.8 MC plug-in unit, respectively.

(2) *LOCAL OSC 152–174 MC plug-in unit.* Four subminiature tubes are used in this unit: First high frequency (hf) oscillator V31, tripler V32, doubler V33, and voltage regulator VR31. These tubes develop a signal which beats with the rf signal in the first mixer stage to produce a 7.8-mc output. The voltage regulator tube (V34) stabilizes the screen voltage of the first hf oscillator. A crystal oven (E31) contains the crystal which determines the frequency of the first hf oscillator. The oven, which also contains a heating element and a thermostat, maintains a temperature of approximately 75° C. Power is supplied to this plug-in unit through plug P32. Rf output is supplied through coaxial plug P31.

(3) *1ST IF 7.8 MC plug-in unit.* This plug-in unit contains three subminiature tubes; the 7.8-mc if. amplifier V51; second mixer V52; and second hf oscillator V53. This plug-in unit amplifies the 7.8-mc output of the RF AMPL 152–174 MC plug-in unit and then beats it with a signal from the second hf oscillator in order to deliver a 455-kilocycle (kc) to selectivity filter Z251 through coaxial plug P53. The 7.8-mc input to this plug-in unit is through another coaxial plug, P52. Power and a front panel test point (RF) are routed through plug P51.

(4) *2ND IF DISCR plug-in unit.* This plug-in unit contains seven subminiature tubes which amplify and amplitude limit the 455-kc if. signal. It also contains two germanium diodes in a discriminator circuit that converts fm to audio signals. Filament filter FL82 is located in this plug-in unit. One coaxial plug, P81, connects the output of the selectivity filter into this plug-in unit. Plug P82 is the connector which carries power to this plug-in unit and also provides connections to three test points at the front of the receiver. These are marked 1ST IF, 2ND IF, and DISCR.

(5) *AUDIO & SQUELCH plug-in unit.* This unit contains four subminiature tubes and one miniature tube. Two tubes are audio amplifiers and the remaining three are used in a squelch circuit. Screwdriver-adjusted audio level control R127 is mounted on this unit and is accessible when the shield cover is removed. All connections to this plug-in unit are made through plug P121.

(6) *RELAY plug-in unit.* This unit is connected to the receiver base through plug P271 and is protected by a shield

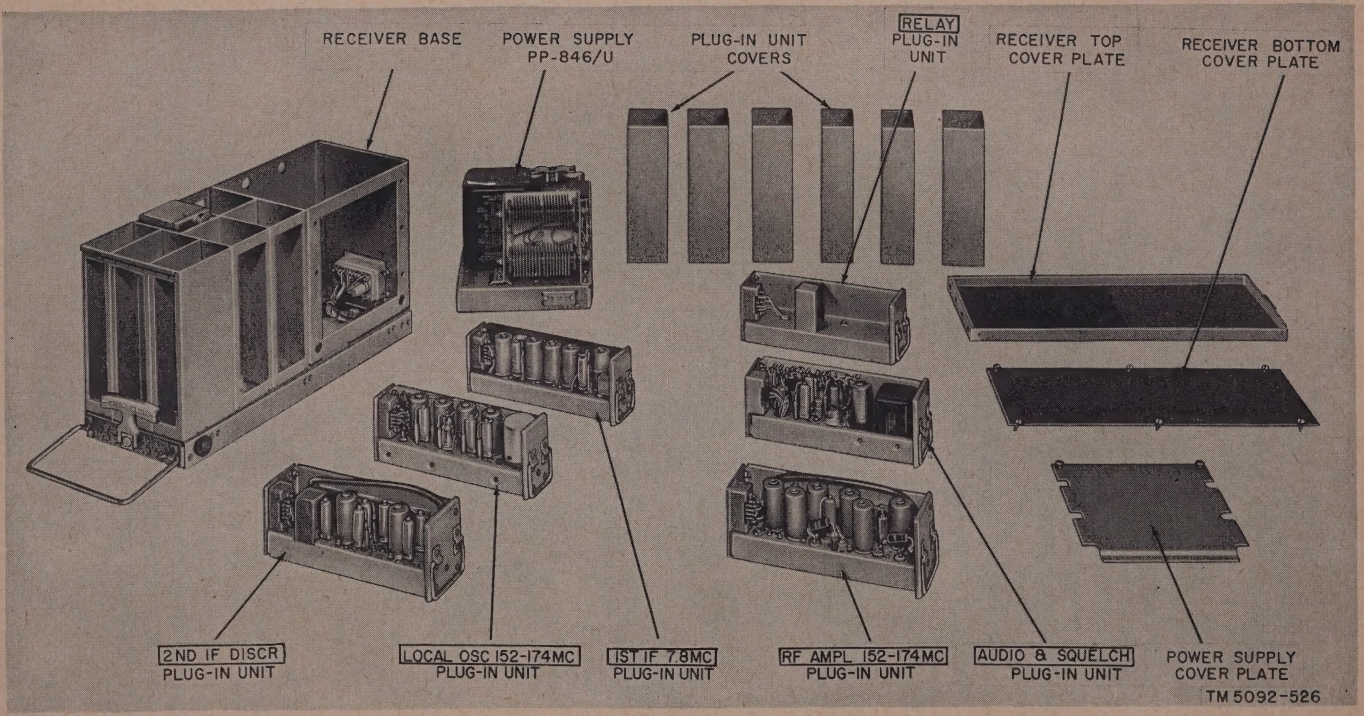

Figure 4. Radio Receiver R-394/U, components disassembled.

cover. When desired, the relay may be wired into the receiver circuit to control a transmitter in a retransmission installation.

(7) *Selectivity filter.* Selectivity filter Z251 is permanently mounted in one of the receiver cells and is connected between the 7.8-mc if. amplifier (V51) and the first 455-kc if. amplifier with coaxial cables. It is a sealed unit with no adjustments and provides the proper band pass for the 455-kc if. stages.

d. Cover Plates. Three cover plates are provided with the receiver. The top cover plate is fastened down with a latch at the rear end of the receiver. The bottom cover plate fastens to the receiver base with six Airloc fasteners, and the side (power supply) cover plate fastens to the receiver base with two Airloc fasteners.

8. Power Supplies

Power Supply PP–846/U (fig. 6) supplies filament, plate, and bias voltages to Radio Receiver R–394/U when used in Radio Receiving Set AN/FRR–36. The power supply chassis mounts in a vertical plane and is fastened to the receiver base with six screws. Voltage is applied to the receiver through jack J3001 on the power supply and plug P251 on the receiver base. This power supply operates on 115- or 230-volt ac. For further details on Power Supply PP–846/U, see TM 11–5078/TO 16–35 PP 846–5. Power Supplies PP–869, PP–868/U, and PP–867/U (all covered in TM 11–5079/TO 16–35 PP 867–5), which also can be used to power the receiver, are similar to Power Supply PP–846/U except that they operate from 6-, 12-, or 24-volt dc, respectively. The power supplies are additional equipments which are furnished as a part of an overall radio set or requisitioned separately.

9. Running Spares

a. No spare parts are furnished with Radio Receiver R–394/U. However, receiver running spares are furnished with the various radio sets in which the receiver is used. Consult the instruction books pertaining to the set used for a listing of receiver spare parts.

b. Since certain tubes used in Radio Receiver R–394/U are used also in the companion transmitter, the quantities supplied as running spares will depend on the total quantity used in both the receiver and the transmitter.

c. Radio Receiver R–394/U uses 22 tubes as follows:

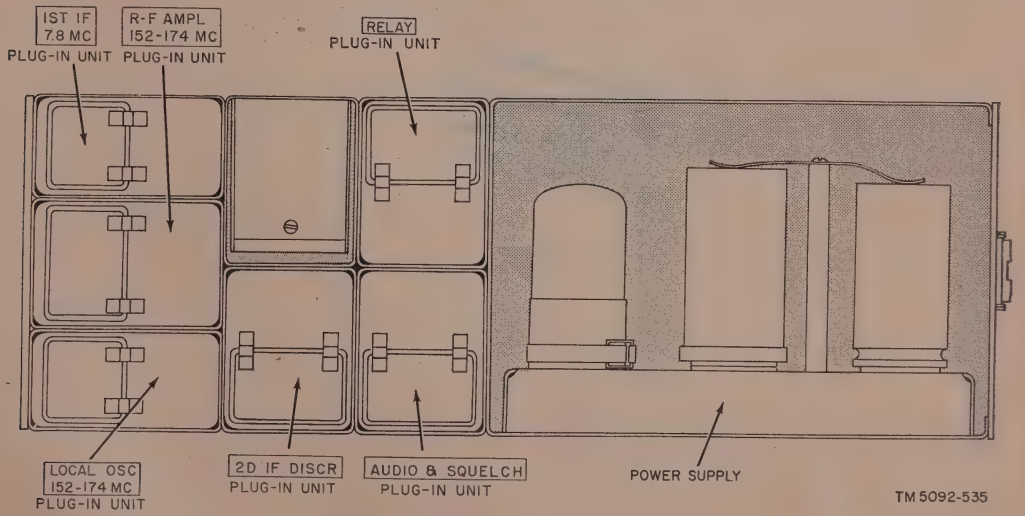
1ST IF 7.8 MC PLUG-IN UNIT
R-F AMPL 152-174 MC PLUG-IN UNIT
RELAY PLUG-IN UNIT
LOCAL OSC 152-174 MC PLUG-IN UNIT
2D IF DISCR PLUG-IN UNIT
AUDIO & SQUELCH PLUG-IN UNIT
POWER SUPPLY
TM 5092-535

Figure 5. Radio Receiver R–394/U, plug-in unit location.

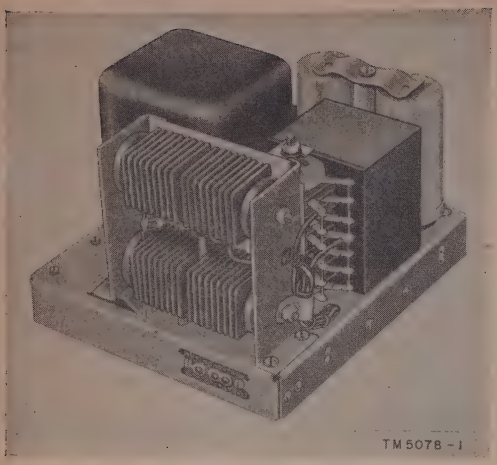

Figure 6. Power Supply PP–846/U.

1 tube 5840
4 tubes 1AD4
1 tube 5783
14 tubes 5678
1 tube 5672
1 tube 6AK6

10. Additional Equipment Required

a. General. Radio Receiver R–394/U requires a power supply and power source, a case (or housing), a control unit, and an antenna for complete operation.

b. Power Supply. The power supply used to power Radio Receiver R–394/U is determined by the radio set and by the power source being employed (par. 8). These power supplies are mounted in the receiver base assembly and are connected to the receiver with a removable plug.

c. Receiver Cabinet. The cabinet that contains Radio Receiver R–394/U is determined by the radio set employed. For purposes of explanation and clarification Electrical Equipment Cabinet CY–1150/U is illustrated and referred to in this technical manual. When Radio Receiver R–394/U is plugged into this cabinet, it forms a complete Radio Set AN/FRR–36.

d. Control. A control unit, including a switch for turning the power on and off, an audio level or volume control, a squelch control and squelch disable switch, also is needed for the operation of Radio Receiver R–394/U. The specific control used also depends on the radio set that is employed. For the purpose of explanation and clarification, in this technical manual the controls of Electrical Equipment Cabinet CY–1150/U (fig. 3) are illustrated and referred to when necessary.

e. Antenna. The antenna used for Radio Receiver R–394/U is a quarter-wave vertical type. Connection is made through a length of coaxial cable.

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CHAPTER 2
OPERATION

Section I. SERVICE UPON RECEIPT OF MATERIEL

11. General

Equipment may be shipped in oversea packing cases or in domestic packing cases and, sometimes in its own carrying case. When new equipment is received, select a location where the equipment may be unpacked without exposure to the elements and which is convenient to the permanent or semipermanent installation of the equipment.

Caution: Be careful in uncrating, unpacking, and handling the equipment; it is easily damaged. If it becomes damaged or exposed, a complete overhaul may be required, or the equipment may be rendered useless.

12. Uncrating, Unpacking, and Checking New Equipment

a. Uncrating and Unpacking. Radio Receiver R–394/U is not packaged as a separate unit but as a component in one of the radio sets incorporating its use. Detailed information pertaining to the unpacking and uncrating of the radio sets is contained in the pertinent radio set instruction book.

b. Checking. Inspect Radio Receiver R–394/U for damage which may have occurred during shipment. If a packing slip is contained in the carton, check it against the contents.

c. Repacking. To repack the receiver, reverse the procedure used for unpacking.

13. Installation of Receiver

a. Before installing the receiver, check it for damage by removing the cover plates and examining the internal parts. To remove the top cover, release the latch at the rear of the receiver (fig. 7). With the top cover off, all the plug-in units can be removed. Remove the shield on each unit (fig. 4) and examine it for the items listed below:

(1) Broken or cracked tubes. (Refer to fig. 8 through 12 for tube locations.)

(2) Cracked, loose or otherwise defective parts, such as resistors, capacitors, terminal boards, and connectors.

(3) Broken wires or frayed insulation.

(4) Dirt, moisture, or foreign material.

(5) Broken or bent pins on plug-in unit connectors.

b. Remove the bottom cover which is secured to the receiver base with six Airloc fasteners. Inspect for defects listed in *a*(2), (3), and (4) above, and for obvious mechanical damage.

c. To remove the side cover, loosen the two Airloc fasteners, and withdraw the cover. Remove the power supply by first disconnecting plug P251 (on the underside of the receiver base) from the power supply connector (fig. 13) and then loosening and unscrewing the six binder head screws. The power supply can now be lifted out of the receiver base assembly. Check for damage to the power supply. Then reinsert the power supply in the receiver base and reconnect P251 to the power supply connector. When using Power Supply PP–846/U, connect a jumper between terminals 7 and 8 of terminal board TB251 on the receiver base.

d. If the receiver passes this inspection satisfactorily, reassemble the plug-in units and insert the receiver in the radio set case. The main receiver connector P252 should engage the connector in the case. After this has been accomplished, tighten the lock-in rod by turning it clockwise.

e. Make sure that the power connector of the radio set is connected and that power is available. The power cable connects either to a 6-, 12-, or 24-volt battery or to a 115- or 230-volt ac line, depending on which radio system is used with Radio Receiver R–394/U. Refer to the pertinent radio set instruction book for specific power connections.

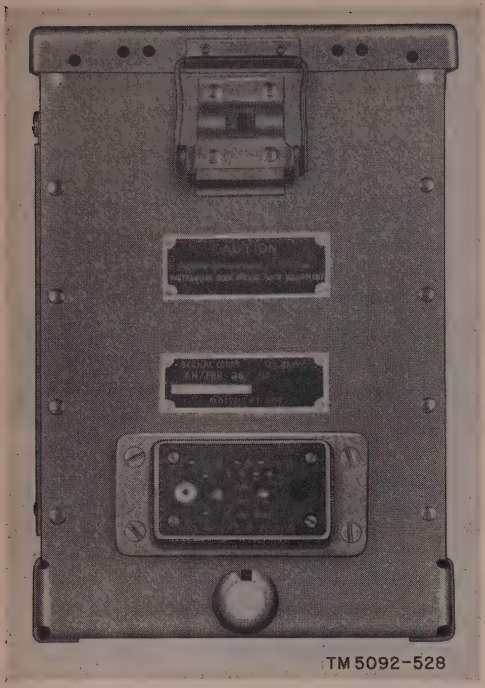

Figure 7. Radio Receiver R–394/U, external connection and cover latch.

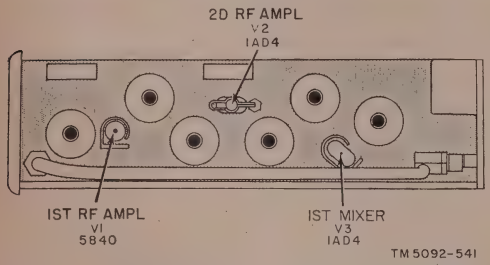

Figure 8. Radio Receiver R–394/U, RF AMPL 152–174 MC plug-in unit, tube location.

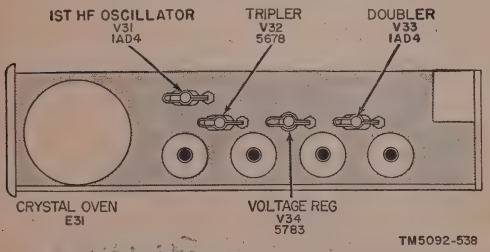

Figure 9. Radio Receiver R–394/U, LOCAL OSC 152–174 MC plug-in unit, tube location.

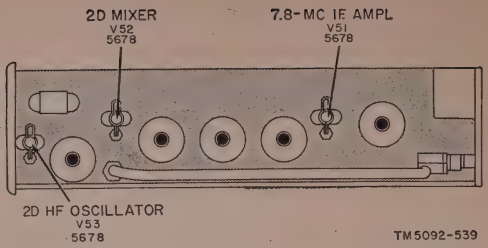

Figure 10. Radio Receiver R–394/U, 1ST IF 7, 8 MC plug-in unit, tube location.

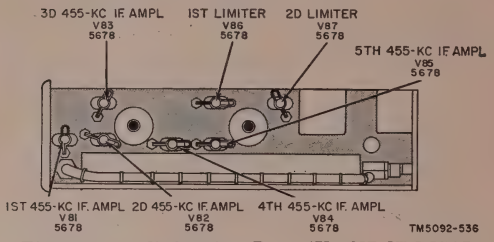

Figure 11. Radio Receiver R–394/U, 2ND IF DISCR plug-in unit, tube location.

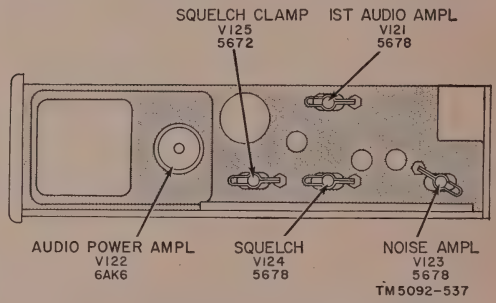

Figure 12. Radio Receiver R–394/U, AUDIO & SQUELCH plug-in unit, tube location.

14. Service Upon Receipt of Used or Reconditioned Equipment

a. Refer to the instructions given in paragraph 12 when unpacking used or reconditioned equipment.

b. Check the used or reconditioned equipment for tags or other indications pertaining to changes in wiring of the equipment. If any changes have been made, note the change in the instruction book, preferably on the schematic diagram. Include the serial and order number of the modified equipments.

c. Follow the installation procedures given in paragraph 13.

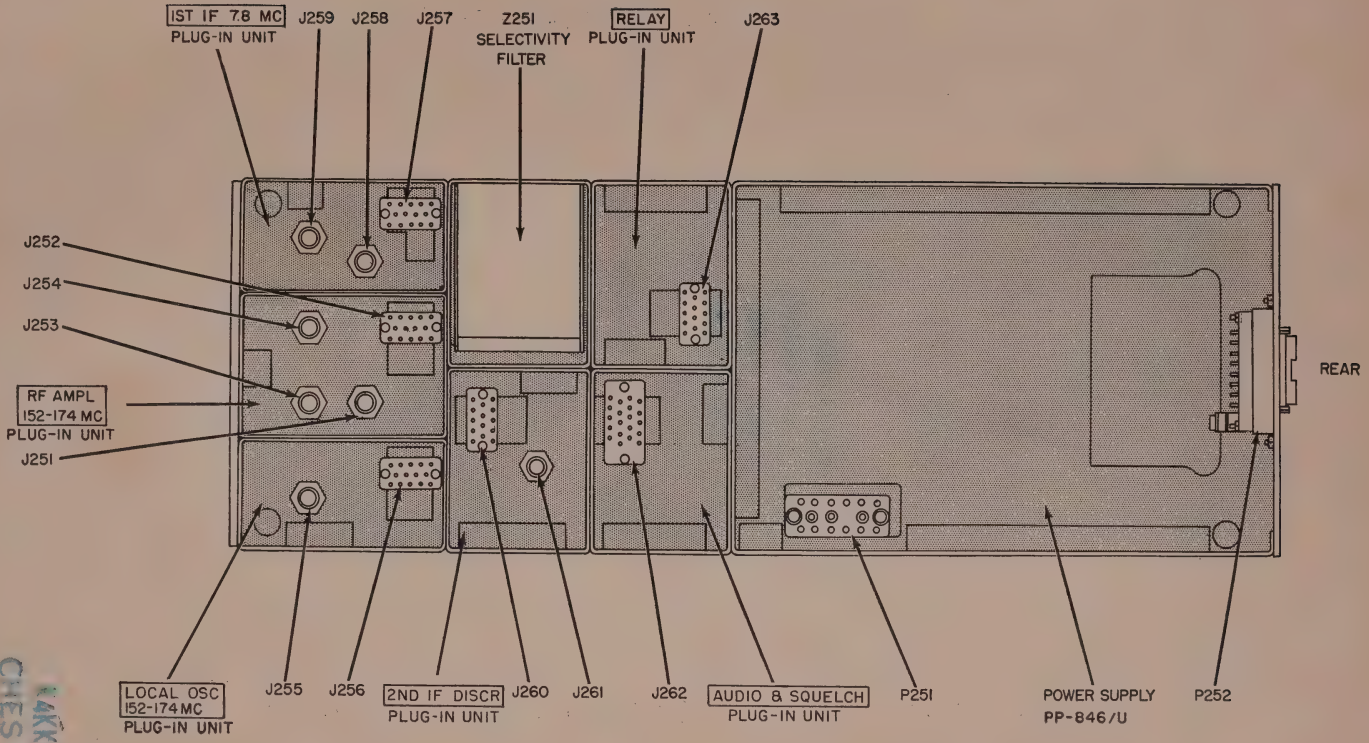

Figure 13. Radio Receiver R-394/U, compartment location.

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Section II. CONTROLS AND INSTRUMENTS

15. General

Haphazard operation or improper settings of the controls often cause damage to electronic equipment. For this reason, it is important to know the function of each control. The actual operation of this equipment is discussed in paragraphs 17 through 21.

16. Controls and Their Uses (fig. 14)

The following chart lists the controls of Radio Receiving Set AN/FRR–36. The controls discussed in this technical manual are the ones contained in Electrical Equipment Cabinet CY–

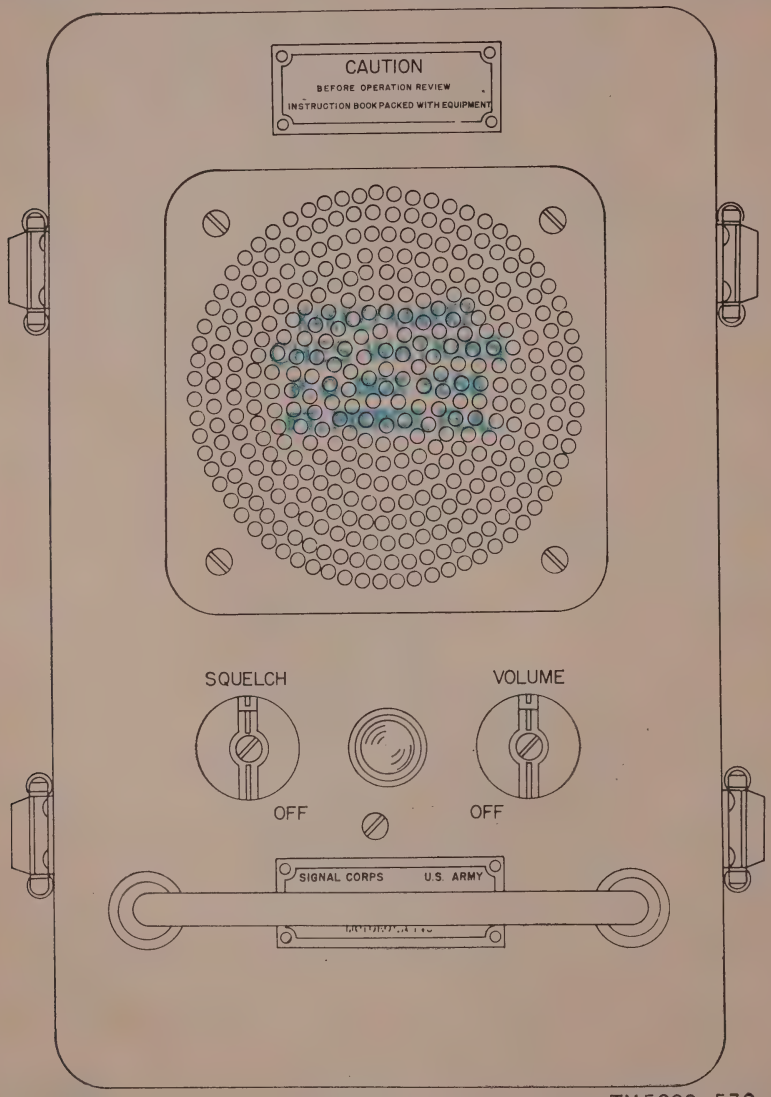

Figure 14. Radio Receiving Set AN/FRR–36, front panel controls.

1150/U and are similar to those in other systems which include Radio Receiver R–394/U.

Control	Function
SQUELCH control (R2408).	Sets the squelch threshold level, as determined by the operator of the receiver. Minimum squelch action is in the clockwise direction.
Squelch OFF switch (S2402).	Ganged to R2408. In the extreme cw position, the switch is closed and prevents the squelch circuit from operating.
VOLUME control (S2401A).	Audio level step attenuator. Operator has option of four fixed audio levels. Maximum volume is in the extreme cw position.
Power OFF switch (S2401B).	Ganged with S2401A. In the fifth or extreme counterclockwise position the switch opens the circuit to the power source (115 or 230 volts ac or 6, 12, or 24 volts dc).
POWER indicator lamp.	Lamp lights when power is turned on.

Section III. OPERATION UNDER USUAL CONDITIONS

17. Initial Adjustment of Receiver

The only adjustment to be performed on Radio Receiver R–394/U prior to actual operation is that of setting it to the required frequency of operation. This operation is performed as follows:

a. Grasp the LOCAL OSC 152–174 MC plug-in unit (location is shown in fig. 13) by the handle and lift it out of the receiver base. Remove the shield cover and locate crystal oven E31 (fig. 9).

b. Remove the crystal oven, use a screwdriver, if necessary, to pry it out of the octal socket. If the use of a screwdriver is required, be careful not to damage the socket or any of the subminiature tubes.

c. Remove the cover from the oven (fig. 15) after first removing the three screws which secure the cover to the base of the oven. Remove the heater element assembly; note the contact arrangement.

d. Insert the proper crystal into the socket provided for it.

Caution: The crystal and the thermostat are similar in appearance except that the thermostat case is black. If in doubt about the proper location of each, refer to the decal fastened to the plug-in unit indicating the proper location.

e. Select the proper Crystal Unit CR–32/U for the frequency of operation desired. Use the following formula for determining the crystal frequency:

$$\text{Crystal frequency (mc)} = \frac{F - 7.8 \text{ mc}}{6}$$

(where F = frequency (in mc) of operation desired).

Example:

If the operating frequency is 165.0 mc, then, crystal frequency

$$= \frac{F - 7.8 \text{ mc}}{6}$$

$$= \frac{165.0 - 7.8 \text{ mc}}{6}$$

$$= \frac{157.2 \text{ mc}}{6} = 26.2 \text{ mc}.$$

f. Reassemble the crystal oven by reversing the disassembly process, and plug it into the octal socket. Reinsert the LOCAL OSC 152–174 MC plug-in unit, *without the shield cover,* into the receiver base.

g. Connect one end of the patch cord (fig. 38) to connector P252 of the receiver, and connect the other end of the patch cord to a connector such as J2401 in Electrical Equipment Cabinet CY–1150/U (fig. 39). Aline the two rf amplifiers, V1 and V2, and the LOCAL OSC 152–174 MC plug-in unit as described in paragraph 91.

18. Starting Procedure

a. Preliminary. Set the VOLUME and SQUELCH controls on the control unit at OFF.

b. Starting. Move the VOLUME control clockwise to the third position. The POWER pilot lamp will light and a signal or rushing noise will be heard from the speaker within 15 or 20 seconds.

19. Volume Adjustment

The volume of the receiver is adjusted by advancing the VOLUME switch clockwise for more output. The operator has an option of four audio volume levels, the lowest being at a position one step clockwise from the OFF position, and the maximum at the fully clockwise position. Adjust the switch for a comfortable level of sound.

20. Squelch Adjustment

a. When the SQUELCH control is in the OFF position, the receiver is unsquelched. This permits the receiver to receive any strength signal without cutting off the audio output. The SQUELCH control can be adjusted to mute the receiver output when a weak signal or no signal is being received. The setting at which this occurs is called the squelch threshold level.

b. Adjust the SQUELCH control as follows:

(1) Turn the SQUELCH control to its fully clockwise position (not OFF) and note whether a signal or just noise is being received.

(2) At an interval when no signal is heard, turn the SQUELCH control counterclockwise until the background noise disappears, *but no further.*

(3) When the noise level is high, and signal strength low, it may be desirable to operate with the SQUELCH control in the OFF position. Otherwise there will be intermittent or no reception. If the squelch circuit behavior is erratic and repair on this circuit is not practical, the squelch circuit can be disabled effectively by setting the SQUELCH control to the OFF position.

21. Stopping Procedure

a. Rotate the SQUELCH control fully clockwise until a click is heard.

b. Rotate the VOLUME control fully counterclockwise to the OFF position.

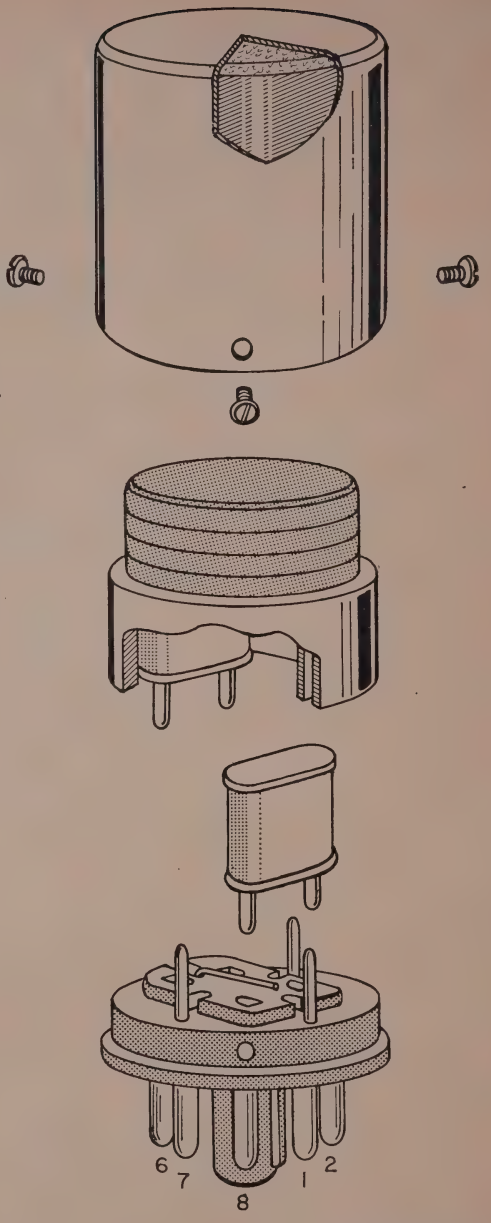

Figure 15. Radio Receiver R–394/U, first high-frequency oscillator crystal oven.

Section IV. OPERATION UNDER UNUSUAL CONDITIONS

22. General

The operation of Radio Receiver R–394/U may be difficult in regions where extreme cold, heat, humidity and moisture, sand conditions, etc., prevail. In the following paragraphs, instructions are given on procedures for minimizing the effect of these unusual operating conditions.

23. Operation in Arctic Climates

Subzero temperatures and climatic conditions associated with cold weather affect the efficient operation of equipment. Instructions and precautions for operation under such adverse conditions follow:

a. Handle the equipment carefully.

b. Keep the equipment warm and dry.

c. If water gets into the handset receiver, or if moisture condenses within it, the actuation of the diaphragm may be impeded. When this happens, remove the bakelite cap, and remove the ice and moisture from the receiver.

d. When equipment which has been exposed to the cold is brought into a warm room, it will sweat until it reaches room temperature. This condition also arises when equipment warms up during the day after exposure during a cold night. When the equipment has reached room temperature, dry it thoroughly.

24. Operation in Tropical Climates

When operated in tropical climates, fixed station radio equipment may be installed in tents, huts, or, when necessary, in underground dugouts. When equipment is installed below ground or in swampy areas, moisture conditions are more acute than normal. Ventilation is usually very poor, and the high relative humidity causes condensation of moisture on the equipment whenever the temperature of the equipment becomes lower than the surrounding air. To minimize this condition, place lighted electric bulbs near (or in) the equipment.

25. Operation in Desert Climates

a. Conditions similar to those encountered in tropical climates often prevail in desert areas. Use the same measures to insure proper operation of the equipment.

b. The main problem that arises with equipment operation in desert areas is the large amount of sand, dust, or dirt that enters the radio equipment. The ideal precaution is to house the equipment in a dustproof shelter. Since such a building is seldom available and would require air conditioning, the next best precaution is to make the building in which the equipment is located as dustproof as possible with available materials. Hang wet sacking over the windows and doors, cover the inside walls with heavy paper, and anchor the side walls of the tent to prevent their flapping in the wind.

c. Never tie power cords, signal cords, or other wiring connections to either the inside or the outside of tents. Desert areas are subject to sudden wind squalls which may jerk the connections loose or break the lines.

d. Be sure that the equipment is as free from dust as possible. Make frequent preventive maintenance checks (ch. 3). Pay close attention to the condition of the lubrication of the equipment. Excessive amounts of dust, sand, or dirt that come into contact with oil and grease result in grit that will damage the equipment.

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CHAPTER 3

ORGANIZATIONAL MAINTENANCE

Section I. PREVENTIVE MAINTENANCE SERVICES

26. Definition of Preventive Maintenance

Preventive maintenance is work performed on equipment (usually when the equipment is not in use) to keep it in good working order so that breakdowns and needless interruptions in service will be kept to a minimum. Preventive maintenance differs from troubleshooting and repair, since its object is to prevent certain troubles from occurring. Refer to AR 750–5, Maintenance Responsibilities and Shop Operation.

27. Tools, Materials, and Test Equipment Supplied with Radio Receiver R–394/U

An alinement tool is supplied with the receiver. However, other items such as Allen wrenches are furnished with the radio set of which the receiver is a component. Consult the instruction book of the radio set incorporating Radio Receiver R–394/U for a listing of the tools, materials, and test equipment provided.

28. General Preventive Maintenance Techniques

a. Use No. 0000 sandpaper to remove corrosion.

b. Use a clean, dry, lint-free cloth or a dry brush for cleaning.

(1) Clean all parts, except electrical contacts, with a cloth or brush moistened with Solvent, Dry Cleaning (SD); then wipe the parts dry with a cloth.

(2) Clean electrical contacts with a cloth moistened with carbon tetrachloride; then wipe them dry with a dry cloth.

Caution: Repeated contact of carbon tetrachloride with the skin or prolonged breathing of the fumes is dangerous. Make sure adequate ventilation is provided. Do not use carbon tetrachloride on polyvinyl insulation; it is a solvent for this resin.

c. If available, dry compressed air may be used at line pressure not exceeding 60 pounds per square inch to remove dust from inaccessible places; be careful, however, or mechanical damage from the air blast may result. Do not use the air blast on speaker cones or meter movements.

d. For further information on preventive maintenance techniques, refer to TB SIG 178, Preventive Maintenance Guide for Radio Communication Equipment.

29. Use of Preventive Maintenance Form (fig. 16)

a. The decision as to which items on DA Form 11–239 are applicable to this equipment is to be made in the case of first echelon maintenance by the communication officer/chief or his designated representative, and in the case of second and third echelon maintenance, by the individual making the inspection. Instructions for use appear on the reverse side of the form.

b. Circled items in figure 16 are partially or totally applicable to Radio Receiver R–394/U. References in the ITEM block refer to paragraphs in the text which contain additional maintenance information.

30. Performing Exterior Preventive Maintenance

Caution: Tighten screws, bolts, and nuts carefully. Fittings tightened beyond the pressure for which they are designed will become damaged or broken.

a. Check for completeness of equipment: spare parts, instruction books, and accessories.

b. Remove moisture from the main receiver connector P252.

SECOND AND THIRD ECHELON MAINTENANCE CHECK LIST FOR SIGNAL CORPS EQUIPMENT
RADIO COMMUNICATION, DIRECTION FINDING, CARRIER, RADAR

INSTRUCTIONS: See other side

EQUIPMENT NOMENCLATURE | EQUIPMENT SERIAL NO.

LEGEND FOR MARKING CONDITIONS: ✓ Satisfactory; X Adjustment, repair or replacement required; (X) Defect corrected.
NOTE: Strike out items not applicable.

NO.	ITEM	1 MONTH
1	COMPLETENESS AND GENERAL CONDITION OF EQUIPMENT (*receiver, transmitter, carrying cases, wire and cable, microphones, tubes, spare parts, technical manuals and accessories*). PAR. 30a	
2	LOCATION AND INSTALLATION SUITABLE FOR NORMAL OPERATION.	
3	CLEAN DIRT AND MOISTURE FROM ANTENNA, MICROPHONE, HEADSETS, CHESTSETS, KEYS, JACKS, PLUGS, TELEPHONES, CARRYING BAGS, COMPONENT PANELS. PAR. 30 b	
4	INSPECT SEATING OF READILY ACCESSIBLE "PLUCK-OUT" ITEMS: TUBES, LAMPS, CRYSTALS, FUSES, CONNECTORS, VIBRATORS, PLUG-IN COILS AND RESISTORS.	
5	INSPECT CONTROLS FOR BINDING, SCRAPING, EXCESSIVE LOOSENESS, WORN OR CHIPPED GEARS, MISALIGNMENT, POSITIVE ACTION.	
6	CHECK FOR NORMAL OPERATION. PAR. 30c	
7	CLEAN AND TIGHTEN EXTERIOR OF COMPONENTS AND CASES, RACK MOUNTS, SHOCK MOUNTS, ANTENNA MOUNTS, COAXIAL TRANSMISSION LINES, WAVE GUIDES, AND CABLE CONNECTIONS. PAR. 30 d	
8	INSPECT CASES, MOUNTINGS, ANTENNAS, TOWERS, AND EXPOSED METAL SURFACES, FOR RUST, CORROSION, AND MOISTURE. PAR. 30e	
9	INSPECT CORD, CABLE, WIRE, AND SHOCK MOUNTS FOR CUTS, BREAKS, FRAYING, DETERIORATION, KINKS, AND STRAIN.	
10	INSPECT ANTENNA FOR ECCENTRICITIES, CORROSION, LOOSE FIT, DAMAGED INSULATORS AND REFLECTORS.	
11	INSPECT CANVAS ITEMS, LEATHER, AND CABLING FOR MILDEW, TEARS, AND FRAYING.	
12	INSPECT FOR LOOSENESS OF ACCESSIBLE ITEMS: SWITCHES, KNOBS, JACKS, CONNECTORS, ELECTRICAL TRANSFORMERS, POWERSTATS, RELAYS, SELSYNS, MOTORS, BLOWERS, CAPACITORS, GENERATORS, AND PILOT LIGHT ASSEMBLIES.	
13	INSPECT STORAGE BATTERIES FOR DIRT, LOOSE TERMINALS, ELECTROLYTE LEVEL AND SPECIFIC GRAVITY, AND DAMAGED CASES.	
14	CLEAN AIR FILTERS, BRASS NAME PLATES, DIAL AND METER WINDOWS, JEWEL ASSEMBLIES.	
15	INSPECT METERS FOR DAMAGED GLASS AND CASES.	
16	INSPECT SHELTERS AND COVERS FOR ADEQUACY OF WEATHERPROOFING.	
17	CHECK ANTENNA GUY WIRES FOR LOOSENESS AND PROPER TENSION.	
18	CHECK TERMINAL BOX COVERS FOR CRACKS, LEAKS, DAMAGED GASKETS, DIRT AND GREASE. PAR. 30f	

NO.	ITEM	1 MONTH
19	ELECTRON TUBES - INSPECT FOR LOOSE ENVELOPES, CAP CONNECTORS, CRACKED SOCKETS; INSUFFICIENT SOCKET SPRING TENSION; CLEAN DUST AND DIRT CAREFULLY; CHECK EMISSION OF RECEIVER TYPE TUBES. PAR. 31 d	
20	INSPECT FILM CUT-OUTS FOR LOOSE PARTS, DIRT, MISALIGNMENT AND CORROSION.	
21	INSPECT FIXED CAPACITORS FOR LEAKS, BULGES, AND DISCOLORATION. PAR. 31 d	
22	INSPECT RELAY AND CIRCUIT BREAKER ASSEMBLIES FOR LOOSE MOUNTINGS; BURNED, PITTED, CORRODED CONTACTS; MISALIGNMENT OF CONTACTS AND SPRINGS; INSUFFICIENT SPRING TENSION; BINDING OF PLUNGERS AND HINGE PARTS.	
23	INSPECT VARIABLE CAPACITORS FOR DIRT, MOISTURE, MISALIGNMENT OF PLATES, AND LOOSE MOUNTINGS.	
24	INSPECT RESISTORS, BUSHINGS, AND INSULATORS, FOR CRACKS, CHIPPING, BLISTERING, DISCOLORATION AND MOISTURE. PAR. 31e	
25	INSPECT TERMINALS OF LARGE FIXED CAPACITORS AND RESISTORS FOR CORROSION, DIRT AND LOOSE CONTACTS.	
26	CLEAN AND TIGHTEN SWITCHES, TERMINAL BLOCKS, BLOWERS, RELAY CASES, AND INTERIORS OF CHASSIS AND CABINETS NOT READILY ACCESSIBLE.	
27	INSPECT TERMINAL BLOCKS FOR LOOSE CONNECTIONS, CRACKS AND BREAKS.	
28	CHECK SETTINGS OF ADJUSTABLE RELAYS.	
29	LUBRICATE EQUIPMENT IN ACCORDANCE WITH APPLICABLE DEPARTMENT OF THE ARMY LUBRICATION ORDER.	
30	INSPECT GENERATORS, AMPLIDYNES, DYNAMOTORS, FOR BRUSH WEAR, SPRING TENSION, ARCING, AND FITTING OF COMMUTATOR.	
31	CLEAN AND TIGHTEN CONNECTIONS AND MOUNTINGS FOR TRANSFORMERS, CHOKES, POTENTIOMETERS, AND RHEOSTATS. PAR. 31f	
32	INSPECT TRANSFORMERS, CHOKES, POTENTIOMETERS, AND RHEOSTATS FOR OVERHEATING AND OIL-LEAKAGE.	
33	BEFORE SHIPPING OR STORING - REMOVE BATTERIES.	
34	INSPECT CATHODE RAY TUBES FOR BURNT SCREEN SPOTS.	
35	INSPECT BATTERIES FOR SHORTS AND DEAD CELLS.	
36	INSPECT FOR LEAKING WATERPROOF GASKETS, WORN OR LOOSE PARTS.	
37	MOISTURE AND FUNGIPROOF. PAR. 31g	

38 IF DEFICIENCIES NOTED ARE NOT CORRECTED DURING INSPECTION, INDICATE ACTION TAKEN FOR CORRECTION.

DA FORM 1 MAY 51 11-239 REPLACES DA FORM 419, 1 DEC 50, WHICH IS OBSOLETE. c0--10--64352-1

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Figure 16. DA Form 11–239.

c. Check for normal operation. If abnormal results occur at any point in the operating procedure, refer to the equipment performance checklist (par. 38).

d. Clean and tighten the receiver case.

e. Inspect metal surfaces for corrosion, dirt, and moisture.

f. Inspect the test points on the front panel for looseness and cracked insulation.

g. If deficiencies noted are not corrected during inspection, indicate on DA Form 11–239 the action taken to initiate correction.

31. Performing Interior Preventive Maintenance

Caution: Disconnect all power before performing the following operations. Upon completion, reconnect power and check for satisfactory operation (par. 38).

a. Inspect the seating of readily accessible *pluck-out* items: All plug-in units, tubes, crystal oven E31, crystal Y51, and all plugs and jacks.

b. Inspect cabling under the receiver base for cuts, breaks, fraying, deterioration, kinks, and strain.

c. Inspect all tubes for loose or damaged terminals and insufficient socket spring tension; clean dust and dirt carefully; check emission of all tubes; refer to figures 8 through 12 for tube location diagrams.

d. Inspect all fixed capacitors for leaks, bulges, and excessive discoloration.

e. Inspect resistors and insulators for cracks, chipping, blistering, discoloration, and moisture.

f. Clean and tighten connections and mountings for audio output transformer T121 and relay K271.

g. Check moistureproofing and fungiproofing.

h. If deficiencies noted are not corrected during inspection, indicate on DA Form 11–239 the action taken to initiate correction.

Section II. LUBRICATION AND WEATHERPROOFING

32. Lubrication

No lubrication is required for Radio Receiver R–394/U.

33. Weatherproofing

a. General. Signal Corps equipment, when operated under severe climatic conditions such as prevail in tropical, arctic, and desert regions, requires special treatment and maintenance. Fungus growth, insects, dust, corrosion, salt spray, excessive moisture, and extreme temperatures are harmful to most materials.

b. Tropical Maintenance. A special moistureproofing and fungiproofing treatment has been devised which, if properly applied, provides a reasonable degree of protection. This treatment is explained in TB SIG 13, Moistureproofing and Fungiproofing Signal Corps Equipment and TB SIG 72, Tropical Maintenance of Ground Signal Equipment.

c. Winter Maintenance. Special precautions necessary to prevent poor performance or total operational failure of equipment in extremely low temperatures are explained in TB SIG 66, Winter Maintenance of Signal Equipment and TB SIG 219, Operation of Signal Equipment at Low Temperatures.

d. Desert Maintenance. Special precautions necessary to prevent equipment failure in areas subject to extremely high temperatures, low humidity, and excessive sand and dust are explained in TB SIG 75, Desert Maintenance of Ground Signal Equipment.

Section III. TROUBLESHOOTING AT ORGANIZATIONAL MAINTENANCE LEVEL

34. General

a. The troubleshooting and repair that can be performed at the organizational maintenance level (operators and repairmen) are necessarily limited by the tools, test equipment, and replaceable parts issued, and by the existing situation. Accordingly, troubleshooting is based on the performance of the equipment and the use of the senses in determining such troubles as burned-out tubes, defective plug-in units, etc.

b. The paragraphs which follow in this section help in determining which of the stages is

defective and in localizing the fault in that stage to the defective item such as a plug-in unit or connector. Figure 41 shows a subassembly partially out of the shield.

35. Visual Check

a. Failure of Radio Receiver R–394/U usually will be caused by one of the following faults:

(1) Defective plug-in unit.

(2) Improperly connected power cables.

(3) Plugs and jacks connecting the plug-in units or power supply improperly seated, loose, or damaged.

(4) Burned-out fuse in the receiver power supply.

(5) Wires loose or broken because of excessive vibration or wear.

(6) Defective or loose tubes.

(7) Inactive (dirty or cracked) hf oscillator crystals.

Note. If the SQUELCH control is advanced too far counterclockwise, no audio output will be obtained. To eliminate this possibility, turn the SQUELCH control fully clockwise until the squelch disable switch is locked in the OFF position.

b. When a receiver failure is encountered and the cause is not apparent, check as many of the foregoing items as is practical and in accordance with the echelon service level handling the receiver. If the operator who was using the receiver at the time of failure is available, consult him for any particulars or details pertaining to the receiver failure.

c. Visually check the antenna system for obvious defects.

36. System Sectionalization of Trouble to Plug-in Unit

Radio Receiver R–394/U is designed so that most defects can be remedied by removing the defective plug-in unit and inserting a similar plug-in unit. When troubleshooting the receiver, replace one plug-in unit at a time until the defective plug-in unit is located. (Replacement of plug-in units may be performed only by qualified personnel.) The plug-in units used for substitution must be properly alined before substitution. The AUDIO & SQUELCH, the 2ND IF DISCR, and the 1ST IF 7.8 MC plug-in units are factory adjusted to a fixed setting regardless of the operating signal frequency, but the RF AMPL 152–174 MC and the LOCAL OSC 152–174 MC plug-in units must be alined accurately to the specific frequency or channel to be used for reception. If the alinement of these last two units is not correct, the receiver will not be tuned to the desired channel. Be sure to determine the operating frequency of the plug-in units beforehand and remember that the RF AMPL 152–174 MC and LOCAL OSC 152–174 MC plug-in units must match (in alinement) to give the desired results. Refer to paragraphs 17 and 91 for alinement of these units.

37. Troubleshooting by Use of Equipment Performance Check List

a. General. The equipment performance check list will help the operator to locate trouble in the equipment. The list gives the item to be checked, the conditions under which the item is checked, the normal indications and tolerances of correct operation, and the corrective measures the operator can take. *To use this list, follow the items in numerical sequence.*

b. Action or Conditions. For some items, the information given in the *action or condition* column consists of various switch and control settings under which the item is to be checked. For other items it represents an action that must be taken to check the normal indication given in the *normal indications* column.

c. Normal Indications. The normal indications listed include the visible and audible signs that the operator should perceive when he checks the items. If the indications are not normal, the operator should apply the recommended corrective measures.

d. Corrective Measures. The corrective measures listed are those the operator can make without turning in the equipment for repairs. If the set is completely inoperative or if the recommended corrective measures do not yield results, troubleshooting is necessary. However, if the situation requires that communication be maintained and if the set is not completely inoperative, the operator must maintain the set in operation as long as it is possible to do so.

38. Equipment Performance Check List

	Item No.	Item	Action or condition	Normal indications	Corrective measures
PREPARATORY	1	Receiver main connector.	Receiver main connector P252 properly engaging its mating connector in the case.		
	2	Power supply connector.	Power supply connector P251 (on receiver) properly connected to its mating connector in the power supply.		
	3	Plug-in unit connectors.	Plug-in unit connectors properly connected. Be sure plug-in units are properly inserted in their respective compartments. Cover should be installed correctly and latched.		
	4	SQUELCH control	SQUELCH control in extreme clockwise position so that squelch disable switch is in the OFF position.		
	5	VOLUME control	VOLUME control in the extreme counterclockwise position so that power switch is in the OFF position.		
START	6	VOLUME control	Advance control clockwise 2 or 3 positions.	POWER indicator lamp lights; rushing noise or signal is heard in speaker.	Check power supply fuse. Check power supply connector P251. Check receiver main connector P252. Check the receiver plug-in units by substitution (par. 36). If this test reveals a defective plug-in unit, tag it as such and replace it.
EQUIPMENT PERFORMANCE	7	VOLUME control	Turn to extreme clockwise position.	Rushing noise or signal is heard at maximum volume.	If the volume of the noise is low or the signal is low and/or distorted, check the plug-in units by substitution (par. 36).
	8	SQUELCH control	(a) With no signal and only noise coming through the loudspeaker, turn this control counterclockwise until the rushing noise stops.	(a) The rushing noise is quieted. If possible, turn on a transmitter tuned to the receiver frequency. This transmitted signal should be audible in the loudspeaker when modulated (speech).	(a) If the squelch control is inoperative check by substituting another AUDIO & SQUELCH plug-in unit (par. 36).

	Item No.	Item	Action or condition	Normal indications	Corrective measures
EQUIPMENT PERFORMANCE			(b) Turn clockwise until rushing noise is heard again.	(b) The receiver is now unsquelched.	(b) If the receiver fails to unsquelch, or the squelching action is erratic, check by substitution of the AUDIO & SQUELCH plug-in unit (par. 36). Check SQUELCH control. See radio set instruction book.
STOP	9	SQUELCH control	Turn fully clockwise so that squelch disable switch is in the OFF position.	Rushing noise or signal continues.	
	10	VOLUME control	Turn fully counterclockwise so that the power switch is in the OFF position.	POWER indicator lamp goes out. No noise or signal is heard in the loudspeaker.	Check for shorted power switch or incorrect radio set connections. See radio set instruction book.

CHAPTER 4
THEORY

39. General

a. Radio Receiver R–394/U is a crystal-controlled, fixed-frequency, double-conversion, superheterodyne, fm receiver. It is designed to operate on a fixed frequency within the 152-mc to 174-mc band. There are four different power supplies which can power this receiver, the selection depending on the power source available and the radio set of which the receiver is a component part.

b. The receiver is not a complete receiving system because it has no controls or power supply. To maintain continuity and completeness of explanation, a 115- or 230-volt power supply (Power Supply PP–846/U) for power and a case (Electrical Equipment Cabinet CY–1150/U), which contains the necessary controls for the operation of the receiver, are referred to in this technical manual. When Radio Receiver R–394/U is used with these components it forms Radio Set AN/FRR–36 which is described in an instruction book.

c. The receiver has six plug-in units which are marked—

(1) RF AMPL 152–174 MC.
(2) LOCAL OSC 152–174 MC.
(3) 1ST IF 7.8 MC.
(4) 2ND IF DISCR.
(5) AUDIO & SQUELCH.
(6) RELAY (Receiver Subassembly MX–1547/G) (optional use).

d. The unique feature of plug-in units necessitates the use of numerous plugs, jacks, and connectors. A thorough familiarity and understanding of these plugs, jacks, and connectors will simplify the work of the technician.

40. Block Diagram
(fig. 17)

a. The signal path through the receiver is shown in the block diagram of figure 17. An fm signal is fed into first rf amplifier V1, where it is amplified and then amplified still further by the action of second rf amplifier V2. The selectivity of the two rf amplifiers also improves the image and if. rejection ratios. The amplified signal is coupled to first mixer V3 together with a signal from the LOCAL OSC 152–174 MC plug-in unit (containing V31, V32, V33, and V34) which is 7.8 mc lower in frequency than the incoming rf signal. Sum and difference frequencies result, but only the difference frequency (7.8 mc) is passed by the following stage, 7.8-mc if. amplifier V51. This stage amplifies the 7.8-mc fm signal, and couples it to second mixer V52. Once again two frequencies are mixed together producing sum and difference frequencies: 7.8 mc from second mixer V52, and 7.345 mc from crystal controlled second high-frequency oscillator V53. The difference (beat) frequency is 455 kc. This 455-kc signal is fed through selectivity filter Z251 which is tuned to the second if. frequency of 455 kc. This signal is then amplified by five 455-kc if. amplifier stages (tubes V81 through V85). The output of tube V85 passes through two limiter stages (V86 and V87) which maintain a constant amplitude voltage output to the discriminator even though the signal from the antenna may fluctuate because of noise or fading. The discriminator stage changes the fm signal into an audio voltage, which is amplified by first audio amplifier V121 and audio power amplifier V122 to a level which facilitates reception with a speaker or handset.

b. Audio output from the discriminator is also fed to a squelch circuit. Noise amplifier V123 amplifies receiver noise and couples this signal to squelch tube V124 which controls the operation of the audio amplifiers (V121 and V122) by biasing their control grids to cutoff when no signal is being received. A SQUELCH control and squelch disabling switch are pro-

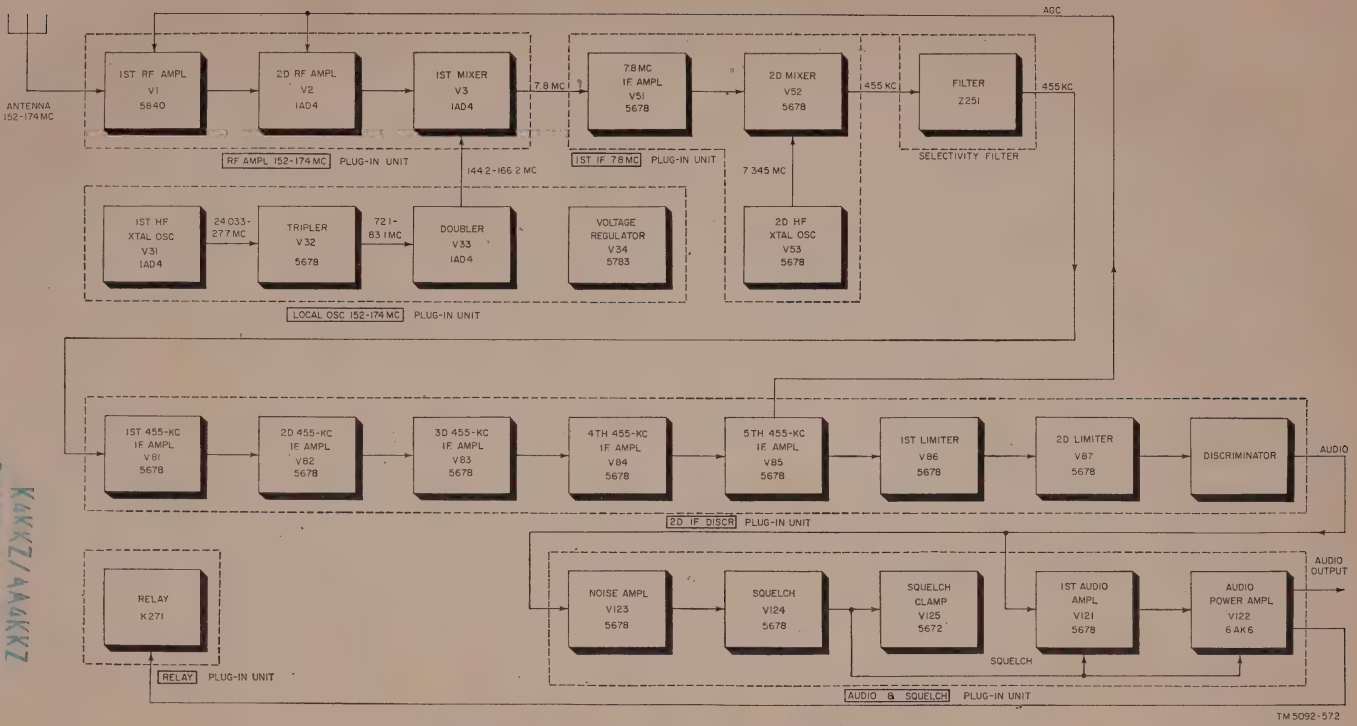

Figure 17. Radio Receiver R-394/U, block diagram.

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vided in the various radio set control units. The squelch clamp tube (V125) reinforces the action of the squelch tube (V124).

c. A RELAY plug-in unit (the use of which is optional) contains a relay which is controlled by audio power amplifier V122. This relay can be used to operate external circuits, such as call signals, or to control a transmitter in a retransmission installation.

d. Strong signals produce a negative voltage at the grid of the fifth 455-kc if. amplifier (V85). A portion of this negative voltage is used as an agc source. The gain of the two rf amplifiers (V1 and V2) is controlled by this agc voltage. The agc voltage varies with the strength of the input signal to the receiver. As the input signal strength increases, this agc voltage increases and lowers the gain of the two rf amplifiers.

41. First Rf Amplifier
(fig. 18)

a. The rf amplifiers amplify the fm signal, which comes from the antenna. No operational tuning of these amplifiers is provided other than the normal alinement (par. 91).

b. The first rf amplifier (V1) uses a subminiature type 5840 tube isolated from stray rf by inclosure in a metal shield. This tube has an indirectly heated cathode. The heater requires 6.3 volts, ac or dc. The signal is fed into the grid circuit of this stage through a coaxial cable at connector P1. The tuned circuit, Z1, consists of coil L1 in parallel with the series combination of capacitors C1 and C2. The impedance of the coaxial cable is matched by tapping down across a portion of the tuned circuit (connecting to the junction of capacitors C1 and C2). R1 is the dc antenna ground return resistor. R2 is the grid-leak resistor. C3 couples the signal from Z1 to the grid of V1. L2 is the rf plate choke. C4 couples the signal from the plate to the tuned circuit (Z2) consisting of L3 and C28. L1 and L3 are slug tuned and can be varied to tune Z1 and Z2 between 152 mc and 174 mc. C12, C13, C24, and C14 are rf bypass capacitors for the grid, filament, screen, and plate circuits, respectively. C28 is a small brass tab, mounted underneath the chassis. It is factory adjusted so that the slug in coil assembly Z2 will adjust the frequency of the plate circuit from 152 to 174 mc. R9 is the screen grid dropping resistor. R3 and C14 are used as a plate decoupling filter.

c. An agc voltage is applied from the grid of the fifth 455-kc if. amplifier (fig. 26) through R2 to the grid of V1. This agc voltage is negative, and it increases the negative bias of V1 and reduces its gain. See paragraph 53 for details of this circuit.

42. Second Rf Amplifier
(fig. 18)

a. This amplifier is similar in function to the first rf amplifier. No tuning of this amplifier is provided other than the normal alinement (par. 91).

b. The second rf amplifier (V2) uses a subminiature type 1AD4 tube. Rf shielding is provided for the tube by a sprayed metallic coating on the outside of the glass envelope which is connected to the filament at pin 3 by a thin wire. This tube has a directly heated filament to which voltage is applied through filament choke L5. This choke and rf bypass capacitors C15 and C26 prevent stray rf from entering the filament circuit. The output from the first rf amplifier is coupled to the grid of V2 through C20. Tuned circuit Z3 (L4, C5, and C6) tunes the grid circuit of this stage. C7 couples the plate output voltage to the tuned circuit of L7 and C30. The grid is connected at the junction of capacitors C5 and C6 to minimize the capacitive loading of V2. R4 is the grid-leak resistor. C32 is an rf bypass capacitor for the grid circuit. L6 is an rf plate choke. Coil assemblies Z3 and Z4 are alined to any one frequency between 152 and 174 mc. C21 couples the signal from the plate circuit of V2 to the grid of the mixer stage (V3). R10 is the screen voltage-dropping resistor. C25 is the screen bypass capacitor. R5 and C16 comprise the plate decoupling filter. C29 and C30 are small brass tabs mounted under the plug-in unit chassis and are factory adjusted to keep the frequency range of Z3 and Z4 within 152 mc to 174 mc.

c. An agc voltage is applied to the grid of V2 through R4. See paragraph 53 for details of the agc circuit.

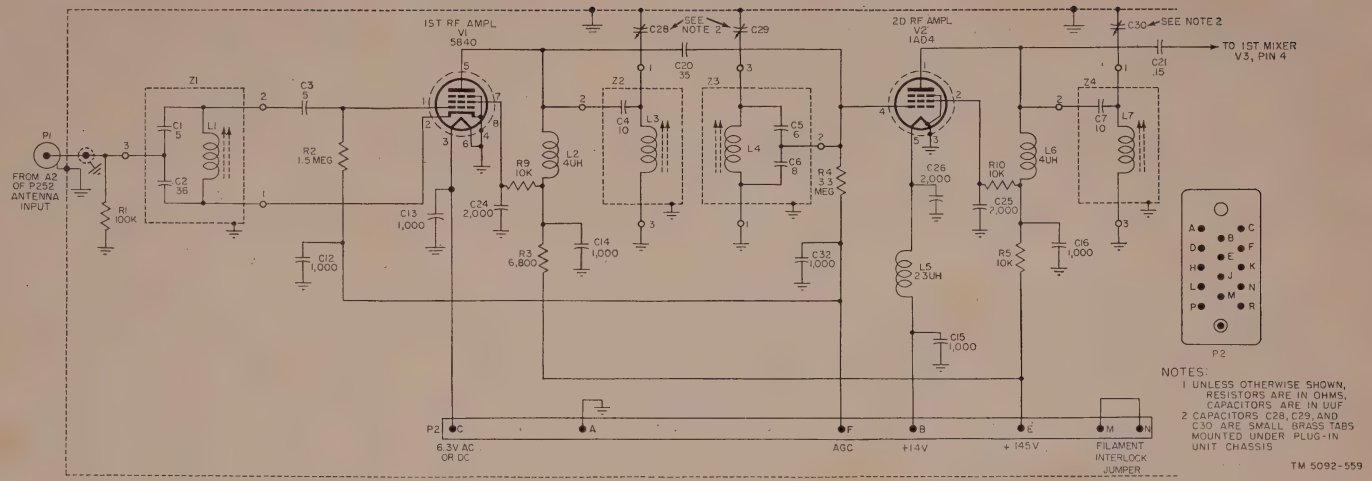

Figure 18. Radio Receiver R–394/U, first and second rf amplifiers.

43. First Mixer
(fig. 19)

a. A signal from the LOCAL OSC 152–174 MC plug-in unit is fed into plug P3 and is injected at the junction of choke coil L9 and the lower side of tuned circuit Z5. L9 is a two-turn coil which keeps the grid circuit of V4 above rf ground to permit the oscillator voltage to be injected. This signal (7.8 mc below the rf signal) beats with the signal coming in on the grid (pin 4) of this first mixer stage to produce sum and difference frequencies. Z6 is tuned to the difference frequency of 7.8 mc, the first intermediate frequency. Some amplification of the signal is provided by this stage.

b. The first mixer stage (V3) uses a subminiature pentode tube type 1AD4. The signal from the second rf amplifier is coupled through C21 to the grid of this stage. Z5 is a tuned circuit which is alined to resonate at any one frequency between 152 and 174 mc. The grid of the tube is connected to the junction of C8 and C9 in such a way as to minimize the capacitive loading of the tuned circuit by the input capacity of the tube. C31 is a brass tab mounted beneath the chassis. Its function is to provide a means of adjusting the grid circuit frequency range. R7 returns the grid to ground. R6 and C17 isolate the test point, marked LO, at the front of the receiver which facilitates testing and alinement. Z6 is the plate tuned circuit. Its output to plug P4 is tapped down in order to match the impedance of the coaxial cable to the following stage. R5 and C16, and R8 and C19 form a two-section decoupling filter for the screen and plate circuit. The four rf coils, L9, L10, L11, and L13 are filament chokes, used with capacitors C18, C22, and C26 to prevent stray rf from entering the filament circuit. R11 is a filament shunting resistor which broadens the bandwidth of local oscillator load choke L11 and assists in suppressing parasitics in the filament circuit.

c. Normally the 1AD4 tube shielding, a sprayed metallic coating, is connected to the filament at pin 3 by a thin wire. The method of signal injection in this circuit from the LOCAL OSC 152–174 MC plug-in unit necessitates breaking this connection between the tube shield and pin 3. Otherwise the injection signal would be shorted to ground. First mixer tube V3 is shielded from stray rf by a tight-fitting cylin-

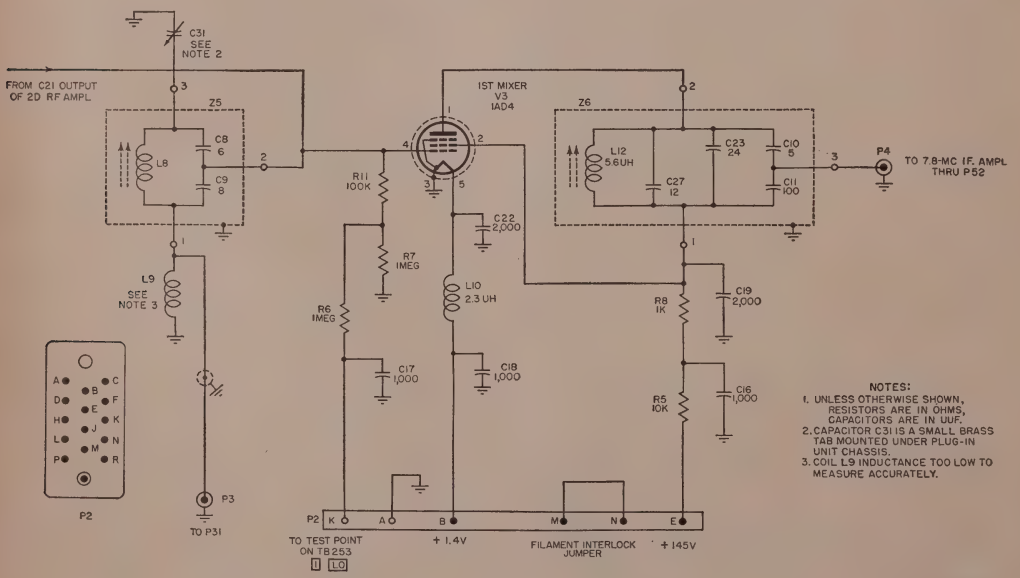

Figure 19. Radio Receiver R–394/U, first mixer.

drical shield mounted on the plug-in unit chassis. A decal fastened to the plug-in unit reminds the technician to break this wire when replacing tubes.

44. LOCAL OSC 152–174 MC Plug-in Unit (fig. 20)

The LOCAL OSC 152–174 MC plug-in unit consists of three stages, discussed in *a* through *c* below.

a. First Hf Oscillator (*V31*). This stage uses a shielded subminiature type 1AD4 tube. The oscillator is a third overtone crystal-controlled oscillator. Because of the stability in frequency required, the crystal is contained in an oven which maintains a constant temperature of approximately 75° C (167° F). To maintain stability, the screen grid voltage of the oscillator is held constant by voltage regulator tube VR31. Crystal oven E31 contains crystal Y31 (Crystal Unit CR–32/U), a heating element, and a thermostat. The heating element is operated from either 24 volts dc or 6 volts ac or dc, depending upon the receiver power supply being used. Rf chokes L40 and L41 and capacitors C43A and C43B are used to keep rf voltages out of the low voltage circuits. Capacitor C49, which is across the contacts of thermostat S31, reduces arcing and rf interference to the oscillator. *Warping* coil Z31 (with stray capacity) is in series with the crystal. This slug tuned coil affords a means of shifting the oscillator frequency slightly to tune the receiver accurately to the incoming signal frequency. A test point is connected to the grid of the oscillator through isolating resistor R40. The output of the oscillator is impedance coupled to a frequency tripler stage through capacitor C34. Rf choke coils L32 and L42 and capacitors C47A, C35B, and C45 are used to keep rf voltages out of the filament circuit. R33 is a screen grid voltage-dropping and regulation resistor. C47B and R32 make up the screen grid decoupling filter. The plate load consists of L33, across which output from the oscillator is developed. R36 and C36 comprise a plate circuit decoupling filter. C46 is a grid circuit rf bypass capacitor for isolating test point 1. R31 functions as a grid-lead bias resistor.

b. Tripler Stage (*V32*). This stage uses a subminiature type 5678 tube. It is an rf amplifier whose plate circuit is slug tuned by means of Z32 to the third harmonic of the frequency developed by the oscillator. The output from the tripler stage is coupled to the doubler stage (V33) through C38 and C39. The grid of the tripler stage is returned to ground through R35. Choke coil L34 and capacitor C35A prevent rf from entering the filament. R37 and C37 form a decoupling filter for the plate and screen grid. V32 is shielded by a sprayed metallic coating which is grounded through pin 3.

c. Doubler Stage (*V33*). This stage uses a subminiature type 1AD4 tube. It is an rf amplifier with a plate circuit (Z34) tuned to the second harmonic of its grid signal. The signal at the output of this stage is six times the frequency delivered by the oscillator (V31). A test point is provided which connects to the grid of this stage through isolating resistor R34. R38 returns the grid to ground. Rf choke coil L37 and C40 isolate the filament circuit for rf. R39 and C50 constitute a plate circuit and screen grid decoupling filter. Rf choke coil L38 impedance couples the plate to Z34 through C42. L39 is tapped down to match the impedance of the coaxial cable terminating at plug P3, which conveys the signal to the first mixer stage, V3. Since the output from the LOCAL OSC 152–174 MC plug-in unit is mixed with the rf signal to produce a 7.8-mc if. frequency, the output frequency of this plug-in unit is 7.8 mc below the rf frequency. Use this formula for determining the crystal frequency:

$$\text{crystal frequency (mc)} = \frac{\text{signal frequency (mc)} - 7.8\text{ mc.}}{6}$$

Tube V33 is shielded from stray rf and radiation by a sprayed metallic coating grounded through pin 3.

45. 7.8-Mc If. Amplifier (fig. 21)

The 7.8-mc if. amplifier (V51) uses a subminiature type 5678 tube. This stage amplifies the signal from the mixer stage (V3). The grid circuit is tuned by Z51. The plate circuit is tuned by three individual tuned circuits, Z52, Z53, and Z54 which are loosely coupled through the low-value capacitors, C58 and C60. These three tuned circuits make this stage very selective. Resistors R54, R58, and capacitors C55B,

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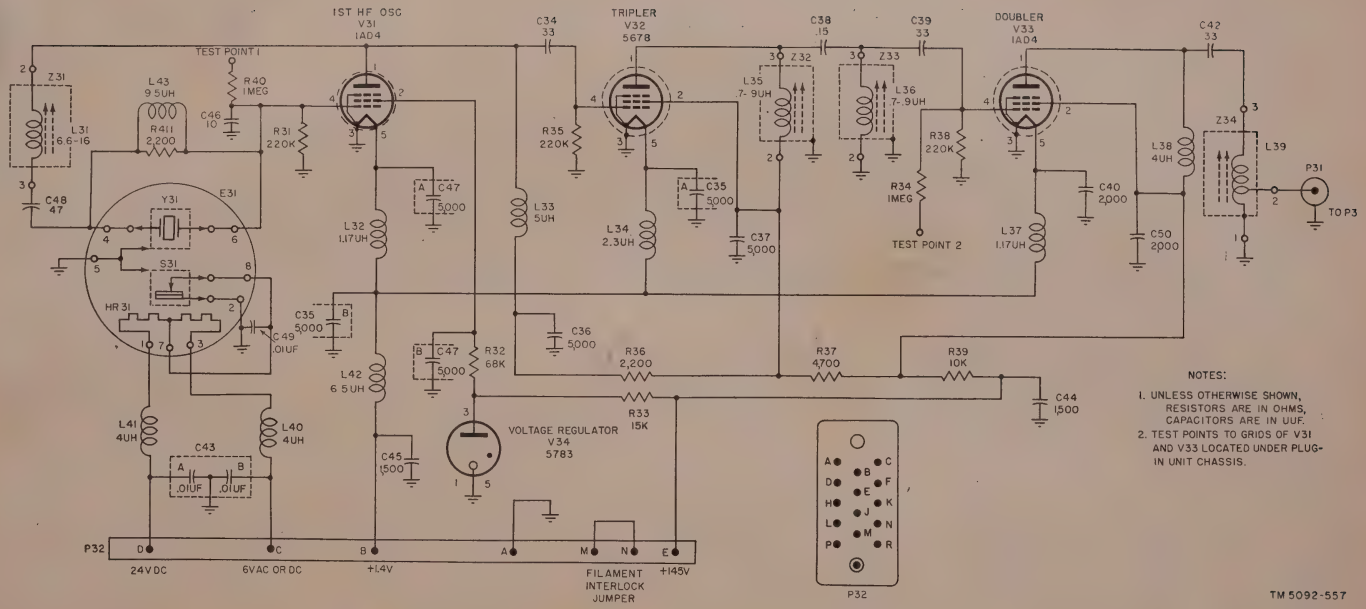

Figure 20. Radio Receiver R–394/U, LOCAL OSC 152–174 MC plug-in unit.

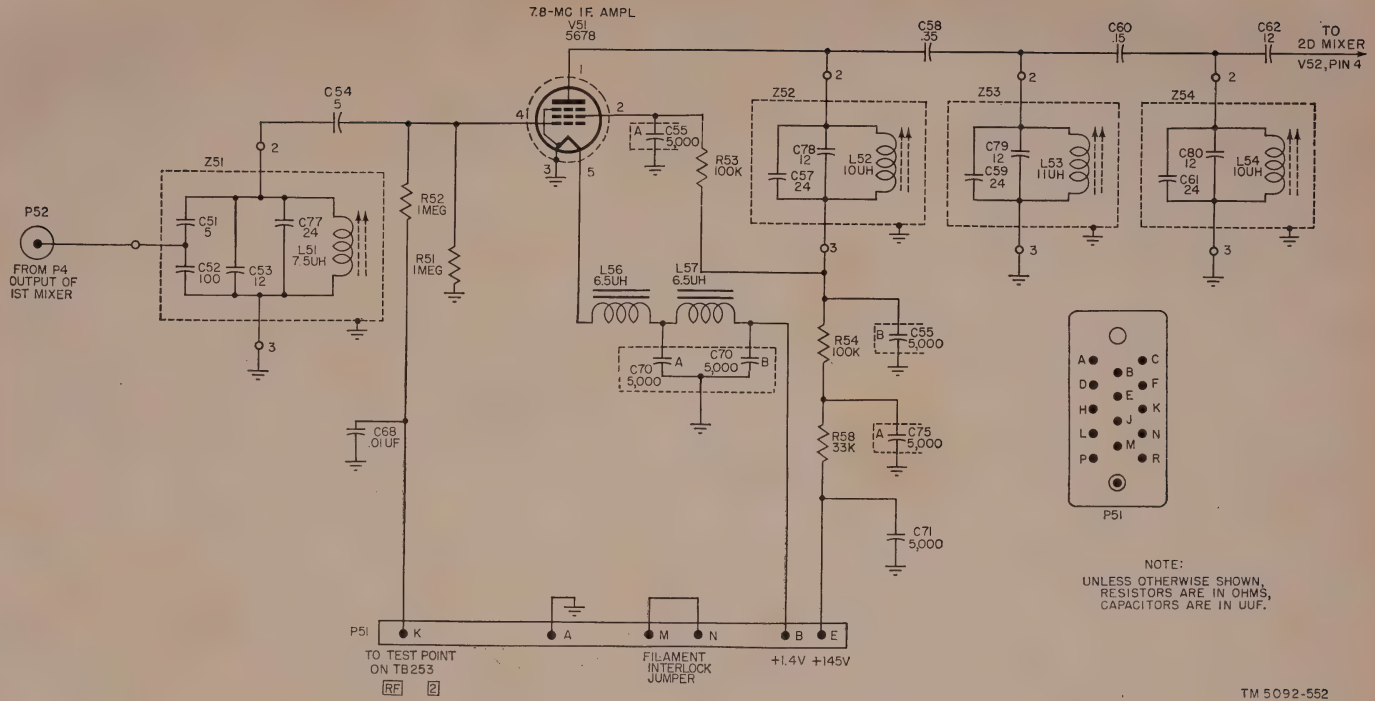

Figure 21. Radio Receiver R-394/U, 7.8-mc if. amplifier.

C75A, and C71 form a plate circuit decoupling filter. The filament circuit is isolated by rf choke coils L56 and L57 and capacitors C70A and C70B. R53 is the screen voltage-dropping resistor and is bypassed by C55A. A test point connection to the grid of this stage is provided through the decoupling filter consisting of R52 and C68. This test point terminates at the front panel of the receiver and is marked RF. Output from the amplifier is connected to the second mixer through coupling capacitor C62. R51 is the grid return to ground. Tube V51 is shielded from stray rf by a sprayed metallic coating which is grounded through a connection to pin 3.

46. Second Mixer
(fig. 22)

a. The function of the second mixer (V52) is that of producing difference frequencies as a result of two signals of different frequencies being present at its control grid. Since the plate circuit is tuned to the difference frequency of 455 kc, all other frequencies are rejected.

b. This stage uses a subminiature tube type 5678 which is shielded from stray rf by a sprayed metallic coating. The grid of this stage receives a 7.8-mc signal from the 7.8-mc if. amplifier (V51). R55 is the grid return to ground. The tuned circuit, Z55, contains a loading resistor (R57) which broadens the frequency response of the circuit to the desired width. The capacitors in this assembly have a negative temperature coefficient which compensates for frequency drift, due to temperature changes. The 455-kc output signal from this stage is connected to plug P53 with a coaxial cable at the junction of C66 and C67. The signal from the second hf oscillator, V53, is connected through C76 and C62 to the grid of the mixer. The value of C76 is very low (1.5 micromicrofarad ($\mu\mu$f)) to isolate the second hf oscillator (V53) from the if. and mixer circuits.

47. Second Hf Oscillator
(fig. 22)

a. The second hf oscillator (V53 develops a 7.345-mc signal which beats with the 7.8-mc signal at the grid of the second mixer stage to produce a 455-kc output at the plate of the mixer.

b. The oscillator is a pentode crystal controlled oscillator. R59 returns the control grid to ground and also develops the grid leak bias. The tube filament is bypassed to ground by

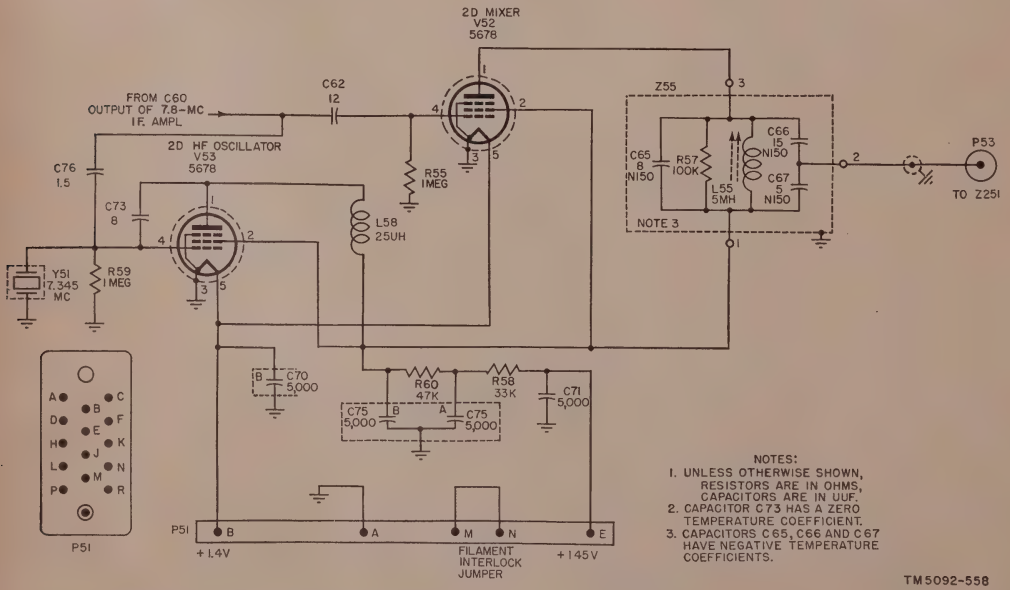

Figure 22. Radio Receiver R–394/U, second mixer and second high-frequency oscillator stages.

C70B. Rf coil L58 with its distributed capacitance, tunes the plate circuit to a frequency slightly higher than the crystal frequency of 7.345 mc. (Crystal Y51 is a type CR–18/U.) This produces an inductive feed-back voltage from plate to grid. Its phase is such as to make the circuit regenerative. C73 shunts the grid-to-plate capacitance of the tube and thus increases the positive feedback to the grid circuit required to sustain oscillation. Plate circuit decoupling is provided by resistors R58 and R60, and capacitors C71, C75A, and C75B. C76 couples the 7.345-mc signal to the grid circuit of the second mixer stage. V53 is shielded by a sprayed metallic coating which connects to ground through pin 3.

48. First 455-kc If. Amplifier
(fig. 23)

The first 455-kc if. amplifier (V81) uses a shielded subminiature tube type 5678. This stage is a resistance coupled amplifier with R84 as the plate load resistance. The selectivity of the 455-kc stages is increased by if. selectivity filter Z251. This filter is fastened to the receiver base permanently and is connected with coaxial cables and connectors between the second mixer V52 and the first 455-kc if. amplifier V81 (fig. 78). The filter is designed to attenuate frequencies which are more than 15 kc above or below 455 kc. The unit is sealed and consists of a network of coils and capacitors. Signal input to the first 455-kc amplifier is through plug P81. A test point connection to the grid of this stage through decoupling resistor R81 can be used to measure the grid bias. It is located on the front panel of the receiver and is marked 1ST IF. C81A is an rf bypass which forms a decoupling filter, together with R81. R82 returns the grid to ground. Filament voltage is supplied through an rf filament filter, FL82. Output to the second 455-kc if. amplifier (V82) is coupled through C82. B+ decoupling is accomplished with resistors R89, R92, R100, R105 and capacitors C83, C86, C101A, C89B, and C101B. B+ voltage is applied through this filter to the plates and screens of the five 455-kc if. amplifiers (V81 through V85) and the two limiter stages (V86 and V87). R83 is the screen grid voltage-dropping resistor for the first and second 455-kc if. amplifiers (V81 and V82). C81B is an rf bypass for both screen grids.

49. Second 455-kc If. Amplifier
(fig. 23)

This stage is similar to the first 455-kc if. amplifier. Resistor R85 is the grid return and resistor R86 is the plate load resistor. The output voltage is applied to the third 455-kc if. amplifier through capacitor C84.

50. Third 455-kc If. Amplifier
(fig. 24)

This stage is a shielded subminiature tube type 5678. A tuned circuit, Z81, in the plate circuit is tuned to 455 kc. Z81 consists of L81 and C87 which are leaded by R110 to broaden the frequency response. Input to the grid is supplied through C84 from the previous stage. Output to the fourth if. amplifier (V84) is applied through C88. Filament voltage is applied through rf filament filter FL82. Plate circuit decoupling is provided by the network of resistors R92, R100, and R105, and capacitors C89B, C101A, and C101B.

51. Fourth 455-kc If. Amplifier
(fig. 24)

The fourth 455-kc if. amplifier, V84, uses a shielded subminiature tube type 5678. This stage is a resistance coupled amplifier. R93 is the grid resistor, R94 is the screen voltage-dropping resistor and R95 is the plate load resistance. The filament circuit is filtered by passing the filament current through filter FL82. Plate circuit decoupling is provided by resistors R100 and R105, and capacitors C89B, C101A, and C101B. C89A bypasses the screen grid to ground. Output from this stage is coupled to the fifth 455-kc if. amplifier through C90. R88 and R111 are part of the agc circuit and are discussed in paragraph 53.

52. Fifth 455-kc If. Amplifier
(fig. 25)

The fifth 455-kc if. amplifier (V85) uses a shielded subminiature tube type 5678. This stage is similar to the other resistance coupled 455-kc if. amplifiers except that the grid-leak bias of this stage is used as an agc voltage (par. 53). R96 is the grid-leak resistor. A test point

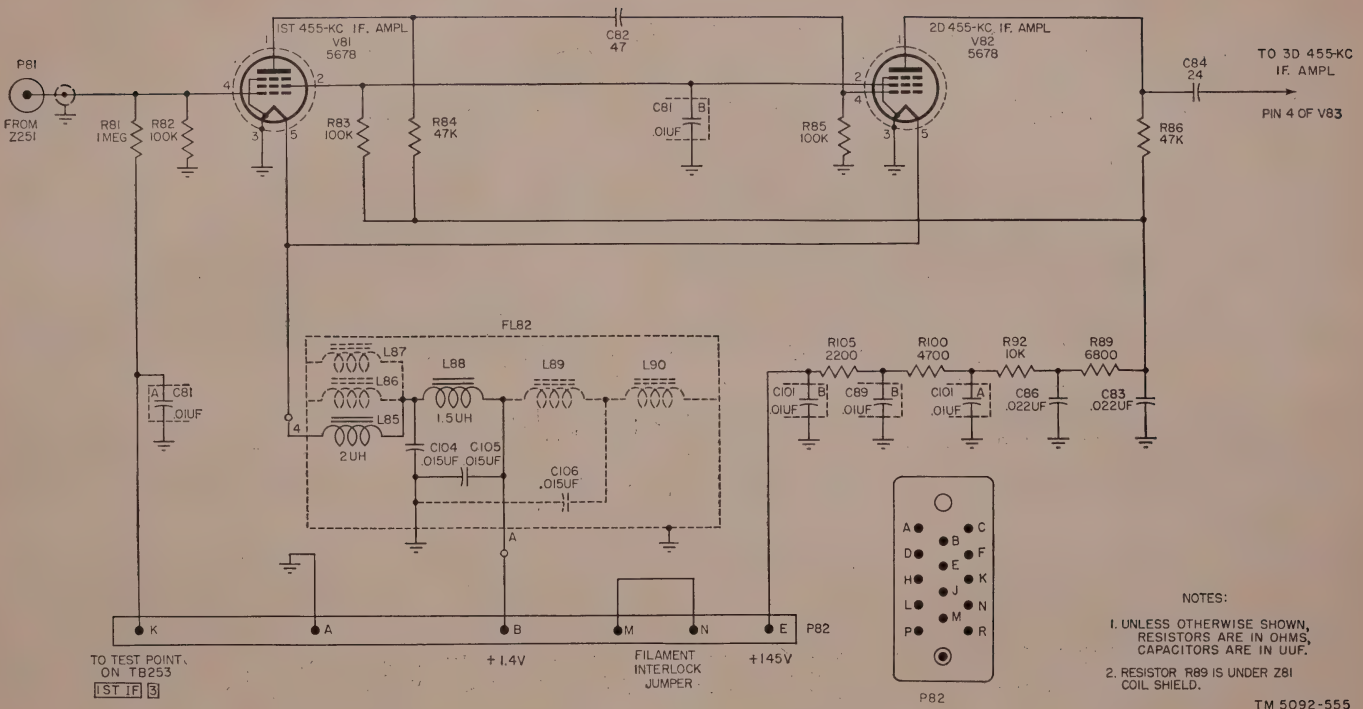

Figure 23. Radio Receiver R–394/U, first and second 455-kc if. amplifiers.

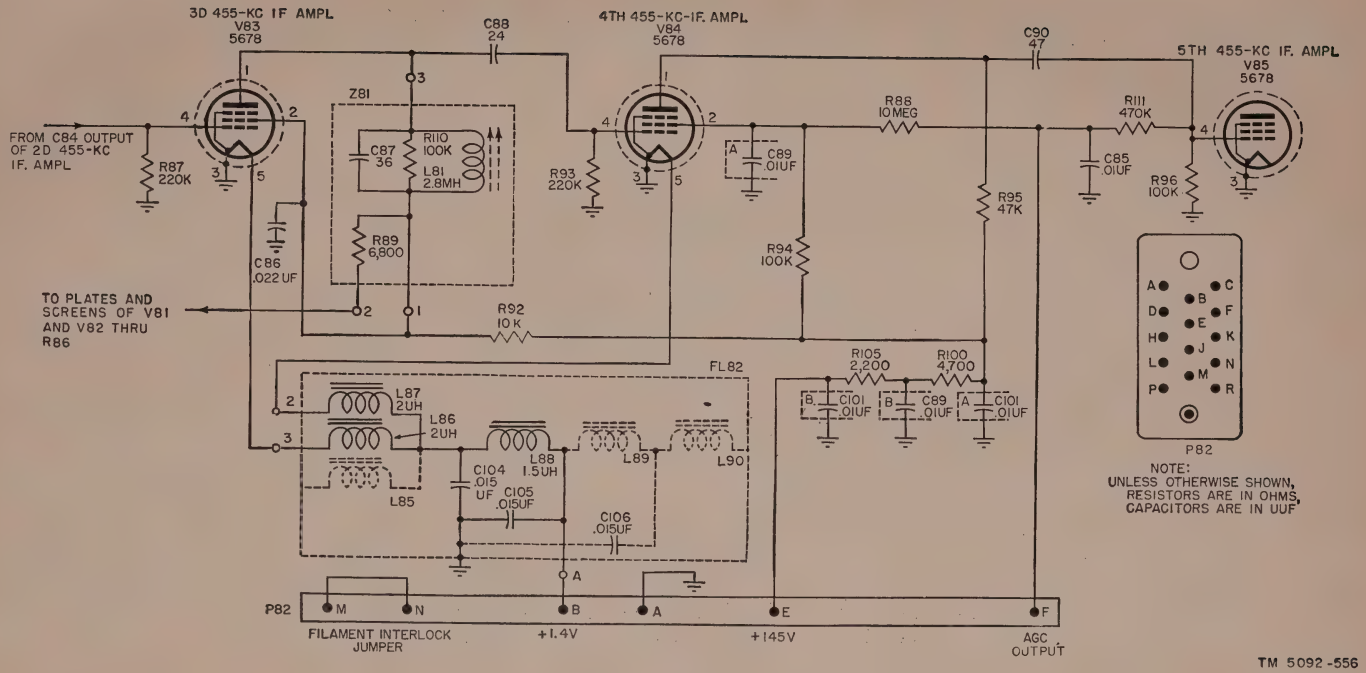

Figure 24. Radio Receiver R–394/U, third and fourth 455-kc if. amplifiers.

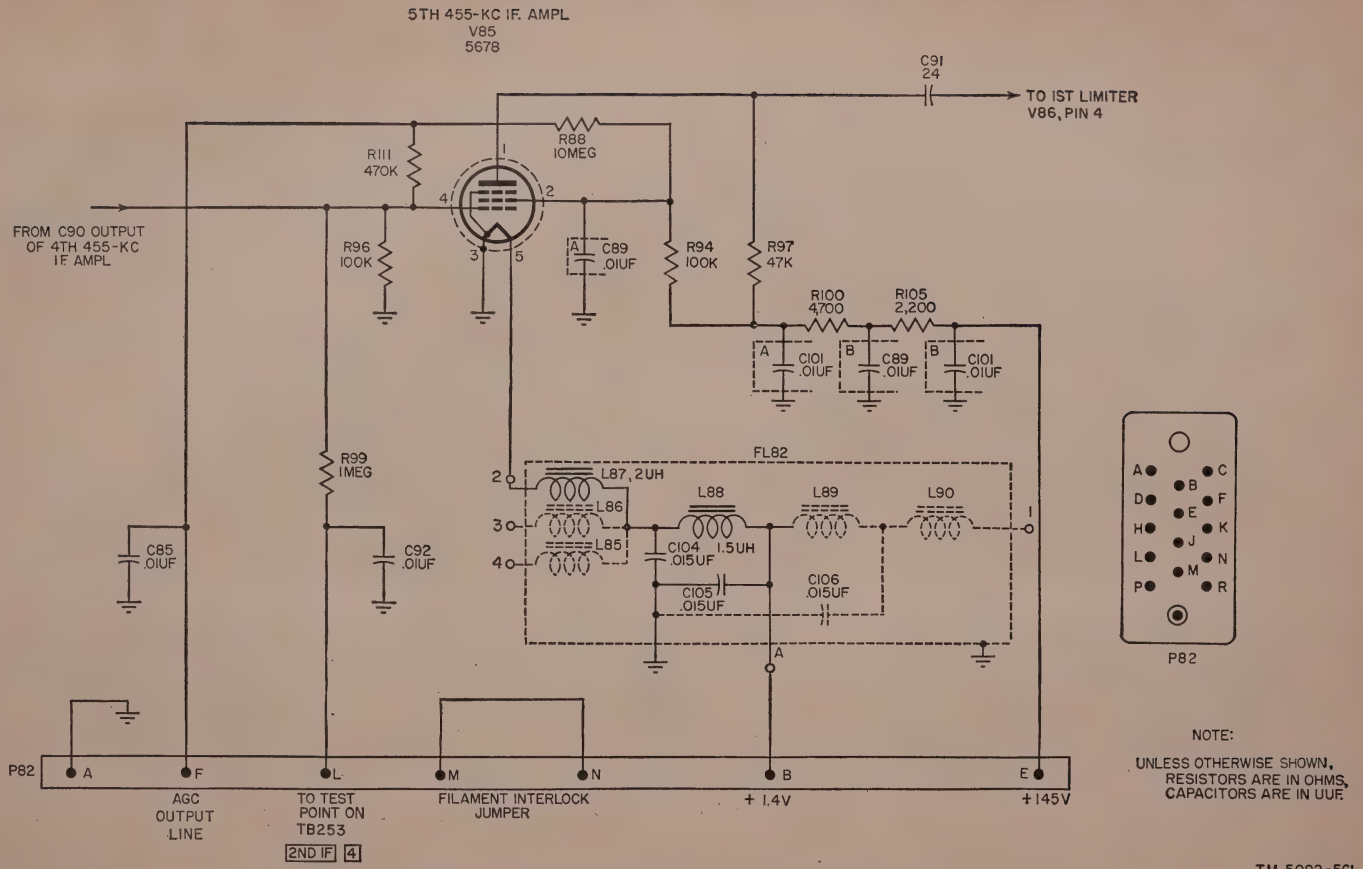

Figure 25. Radio Receiver R–394/U, fifth 455-kc if. amplifier.

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connection to the control grid is provided through isolating resistor R99. This test point (marked 2ND IF.) terminates at the front panel of the receiver, and is bypassed for the intermediate frequency by C92. R94 is the screen voltage-dropping resistor and C89A is the screen bypass. R97 is the plate load resistance, across which the output voltage is developed. R100 and R105, and C101A, C89B, and C101B, form a plate circuit decoupling filter. Filament current is filtered through filter FL82. See paragraph 53 for a discussion of C85, R88, and R111. Output is coupled to the control grid of first limiter V86 through C91.

53. Agc Circuit (fig. 26)

The agc circuit controls the gain of the two rf amplifiers. A negative bias voltage, obtained from the grid-leak bias of the fifth 455-kc if. amplifier is used to increase the negative bias of the rf amplifiers and reduce their gain. The grid-leak bias of the fifth 455-kc if. amplifier varies with the strength of the signal applied. Therefore, stronger applied signals produce a greater negative bias at the grid of this tube. This increased negative bias reduces the gain of the two rf amplifiers and prevents overloading of the rf amplifiers. It also reduces the difference in gain among different units of Radio Receiver R–394/U and among replacement tubes in any one receiver.

a. The negative grid-leak bias of the fifth 455-kc if. amplifier (V85) is developed across grid-leak resistor R96. The voltage at the junction of R96 and R111 has a value of about —5 volts. This is too large a negative voltage to apply to the grids of the rf amplifiers. Therefore a voltage divider is set up between the screen grid of V85, which is at a potential of about +80 volts and the control grid, which is at about —5 volts with respect to ground. This voltage divider consists of R88 and R111. The values of these two resistors are such as to produce a small negative voltage (much smaller than 5 volts) at the junction of R111 and R88. This voltage is the agc voltage which is applied to the rf amplifiers.

b. When the strength of the input signal to the receiver changes, the grid-leak bias of V85 changes. Practically the same change in voltage occurs at the junction of R111 and R88. (If an ordinary circuit were used, making use of a potentiometer for R96 to reduce the agc voltage applied to the rf amplifiers, only a small portion of the change in grid-leak bias across R96 would occur in the agc voltage. This would result in a weaker agc action.) The voltage at this junction is applied through a decoupling filter (C85, R254, and C252) to the grid circuits of the rf amplifiers to control their gain. C12 and R2, and C32 and R4 are additional decoupling filters, which prevent any rf picked up in the wiring from being applied to the grids of the rf amplifiers.

c. A test point marked 2ND IF. is connected through decoupling filter C92 and R99 to the grid of V85. This test point is on the front panel of the receiver.

54. First Limiter (fig. 27)

a. The function of the first limiter stage (V86) is that of reducing or eliminating large signal amplitude variations which may be present in the output from the fifth 455-kc amplifier. Strong signals produce grid-leak bias at the grid of V86 and operate the tube near cut-off. This clips the negative half-cycles of grid voltage. The positive half-cycles operate the tube at its plate current saturation point. Thus both halves of a strong signal are clipped and the ac output of this tube has almost a constant amplitude. Weak signals are amplified.

b. Filament current is filtered by filament filter FL82. Grid bias is developed across grid-leak resistor R98. Resistors R103, R104, and R105 and their bypass capacitors C93, C89B, C101B, and C102 decouple the plate circuit from the B+ supply. Z82, the plate load, is resonant at 455 kc. The signal output is coupled to the second limiter through coupling capacitor C95.

55. Second Limiter (fig. 28)

a. The second limiter (V87) uses a shielded subminiature pentode tube type 5678. Its function is similar to that of the first limiter, V86. It removes any amplitude variations in signal that were not completely eliminated by the first limiter stage. This limiting action occurs be-

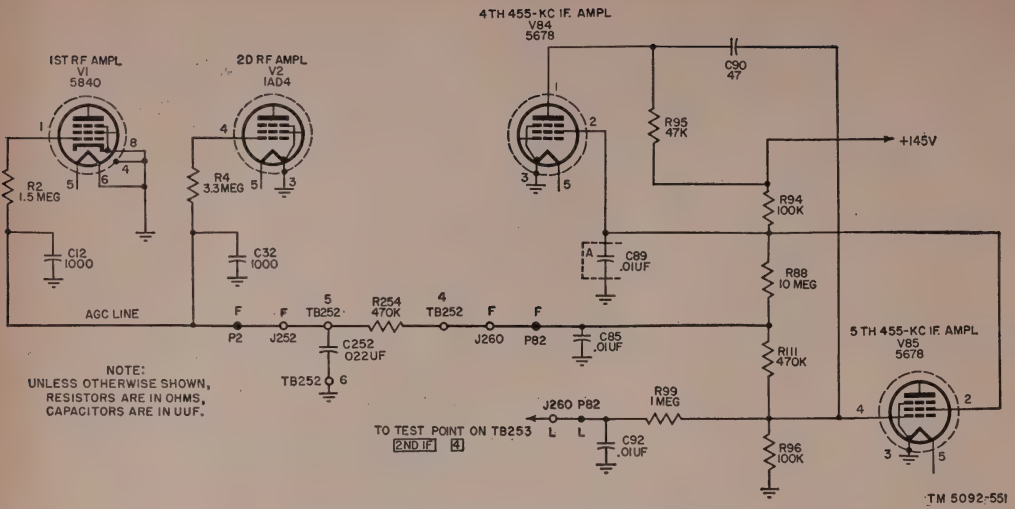

Figure 26. Radio Receiver R–394/U, agc circuit.

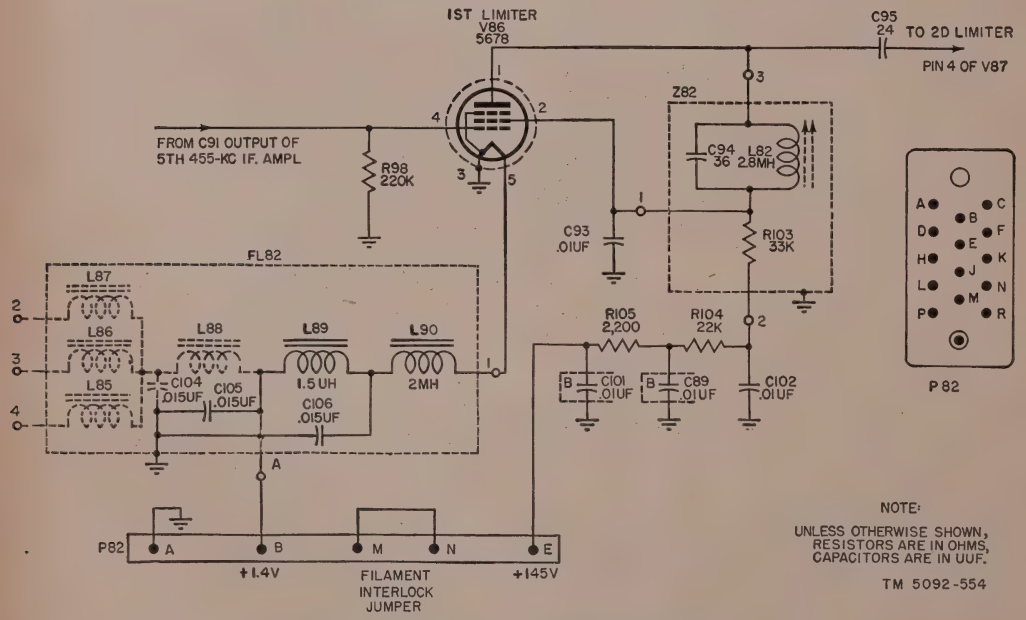

Figure 27. Radio Receiver R–394/U, first limiter.

cause of a high negative grid leak bias and low plate and screen voltages. When the control grid swings into a negative cycle the plate current cuts off, and when the grid swings positive, plate current saturation results, thus limiting the positive and negative peaks of output voltage.

b. Output from the first limiter (V86) is applied to the grid of the second limiter. A high grid-leak bias is developed across grid-leak resistor R102. A connection to the grid through isolating filter R101 and C96 is available as a limiter grid bias test point. This test point is located on the 2ND IF. DISCR plug-in chassis. Filament current is supplied through FL82. Screen and plate voltages are supplied from the B+ supply through a double pi-section filter consisting of C101B, R105, C89B, R104, and C102. The connection to the plate is through the primary circuit of T81. T81 is the discriminator transformer assembly. Details of this circuit are described in paragraph 56.

56. Discriminator

a. General. The discriminator is a modified Foster-Seely circuit which consists of transformer assembly T81, two germanium diode rectifiers, CR81 and CR82, and associated resistors and capacitors. It converts the fm output signal of second limiter V87 to an audio signal. The fm signal from the second limiter has a center frequency of 455 kc and varies above and below this frequency at the rate of the audio signal by which it is modulated. The maximum deviation from the center frequency is ±15 kc. The primary and secondary circuits of T81 are tuned to 455 kc and have a band pass of ±38 kc. This excess width produces a flat response of both tuned circuits to signals with a frequency of 455 kc ±15 kc.

b. Circuit Analysis (fig. 28). The input signal to the discriminator is applied across the primary circuit of T81 and to the junction of C108 and C109 in the secondary circuit of T81. The voltage across L91 produces a current through L91 which induces a voltage in L92; this voltage is in phase with the voltage applied to the primary circuit (L91). (The induced voltage across the secondary of a transformer is either in phase or 180° out of phase with the primary voltage, depending on the relationship of the two coil windings.) The induced voltage across L92 (E_s) produces a current (I_s) through the tuned secondary circuit (a series resonant circuit). This current is in phase with the induced voltage across L92 at the center frequency (455 kc), lags the induced voltage at frequencies above the center frequency, and leads the induced voltage at frequencies below the center frequency. Since the induced voltage across L92 is in phase with the primary voltage, the current in the secondary circuit has the same phase relationship to the primary voltage as it does to the induced secondary voltage.

c. If. Voltage at CR81 and CR82 (figs. 28 and 29). The if. voltage at CR81 is equal to the vector sum of two voltages in series. The first is the voltage applied directly to the junction of C108 and C109. The second is the voltage developed across C108 by the current (I_s) flowing through this capacitor. Similarly, the voltage at CR82 is equal to the vector sum of the voltage applied to the junction of C108 and C109, and the voltage developed across C109 by the current (I_s) flowing through this capacitor. The voltage across a capacitor lags the current flowing through it by 90°.

(1) At the center frequency, when the current (I_s) is in phase with the applied voltage, the voltage across C108 lags the applied voltage, E_p (voltage at the junction of C108 and C109) by 90°. The vector sum of the applied voltage, E_p, and the voltage E_1 across C108, is shown on figure 29 Ⓐ, and is represented by the resultant vector, E_{CR81}. To obtain the voltage at CR82, add vectorially the voltage across C109, E_2, to the applied voltage, E_p, in the opposite sense from that of C108. Therefore, on figure 29Ⓐ, E_2 is drawn straight up and is 180° out of phase with E_1. The resultant vector, E_{CR82}, represents the voltage at CR82. Although both resultant voltages differ in phase, their magnitudes are equal.

(2) When the applied voltage is above the center frequency, the current, I_s, through the secondary circuit, lags the applied voltage. In figure 29Ⓑ,

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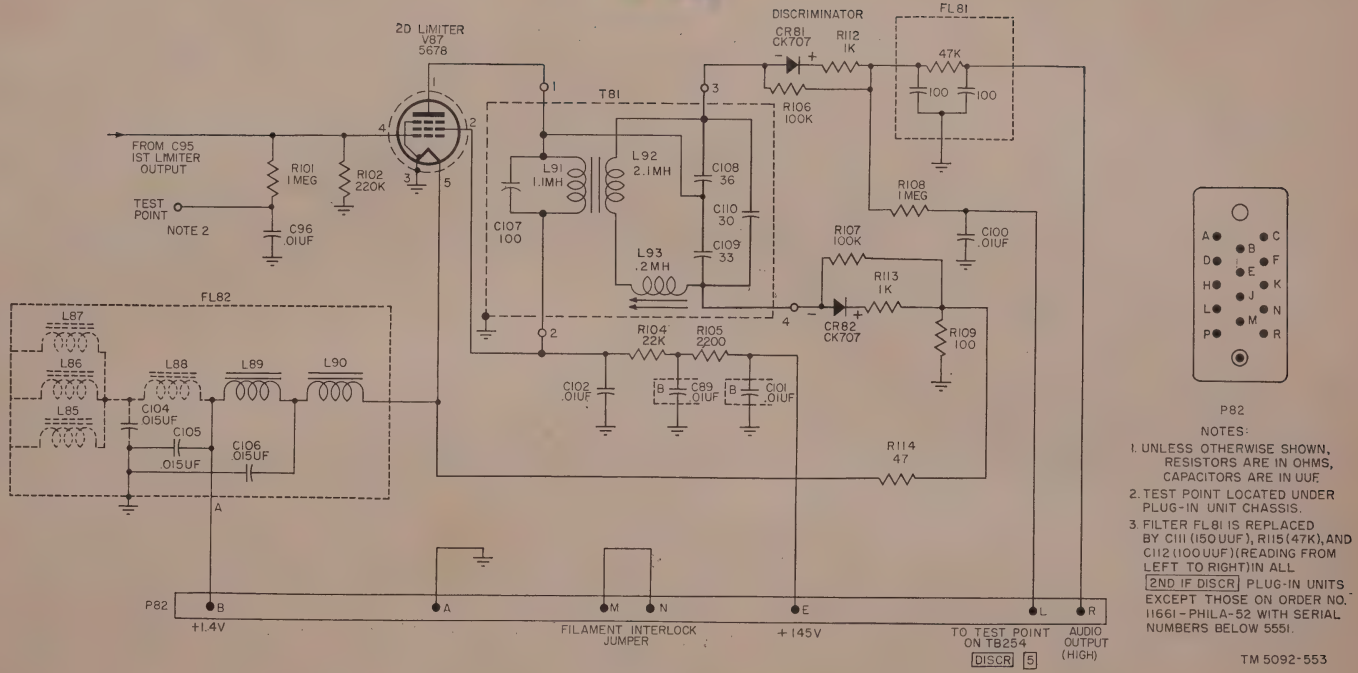


P82

NOTES:

1. UNLESS OTHERWISE SHOWN, RESISTORS ARE IN OHMS, CAPACITORS ARE IN UUF.
2. TEST POINT LOCATED UNDER PLUG-IN UNIT CHASSIS.
3. FILTER FL81 IS REPLACED BY C111 (150 UUF), R115 (47K), AND C112 (100 UUF) (READING FROM LEFT TO RIGHT) IN ALL [2ND IF DISCR] PLUG-IN UNITS EXCEPT THOSE ON ORDER NO. 11661-PHILA-52 WITH SERIAL NUMBERS BELOW 5551.

TM 5092-553

Figure 28. Second limiter and discriminator.

E_1 is shown lagging I_s by 90° and E_2 is shown leading I_s by 90°. In this case it is apparent that the if. voltage at CR82 is greater than that at CR81.

(3) When the applied voltage is below the center frequency, the current, I_s, through the secondary circuit leads the applied voltage, E_p. In figure 29©, E_1 is again shown lagging I_s by 90° and E_2 is shown leading I_s by 90°. In this case it is apparent that the if. voltage at C81 is greater than that at CR82.

d. Output Voltage of Discriminator. The output of the discriminator is at terminal R of P82 (fig. 28). When there is no discriminator output, this point is at a potential of approximately +1 volt. This is the potential across R109, obtained from the 1.4-volt filament supply through voltage-dropping resistor R47. This low positive voltage provides a bias to CR82 and prevents low hum voltages from entering the discriminator circuit. Since the output of the discriminator is applied to first audio amplifier V121 and to noise amplifier V123 through coupling capacitors, this dc voltage has no effect on these stages. Only changes in the dc output which occur at an audio rate are passed to these stages.

(1) When the if. signal applied to the discriminator is at the center frequency (445 kc), the voltages at CR81 and CR82 are equal, and equal dc voltages are developed across R106 and R107. These two voltages, which are connected through L92 and L93, are series opposing. Therefore, the dc output of the discriminator remains unchanged.

(2) When the if. signal applied to the discriminator is above the center frequency, the voltage at CR82 exceeds that at CR81 and the dc voltage across R107 exceeds that across R106. This causes the dc output of the discriminator to drop.

(3) When the if. signal applied to the discriminator is below the center frequency, the if. voltage at CR81 exceeds that at CR82 and the dc output across R106 exceeds that across R107. This causes the dc output of the discriminator to rise.

(4) Since the frequency of if. signal varies at an audio rate, the dc output of the discriminator varies at an audio rate. If. voltages are bypassed to ground by if. filter FL81 or by C111, R115, and C112 as indicated in note 3 of figure 28. The instantaneous dc output of the discriminator is shown on figure 30 (discriminator frequency response curves). The two curves indicate the tolerance limits for a satisfactory discriminator.

e. Miscellaneous. L93, located in the secondary of T81, is adjustable for tuning the discriminator circuit to the if. center frequency. R112 and R113 are balancing resistors which equalize the forward resistance of the CR81 and CR82 circuits. R108 and C100 form a decoupling filter for the test point on the front of

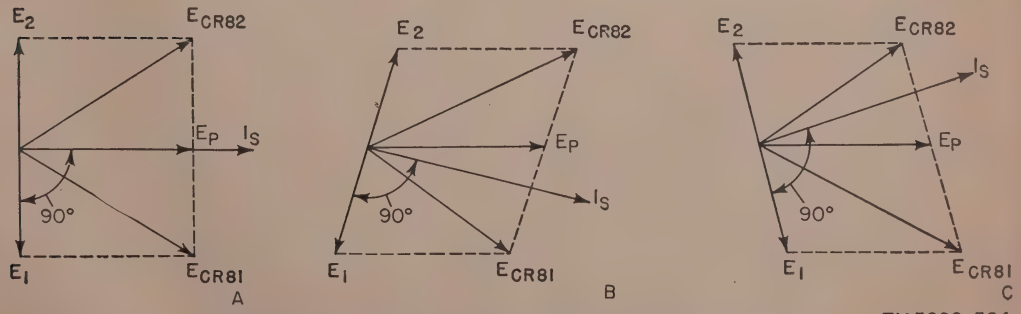


Figure 29. Radio Receiver R–394/U, discriminator vector diagrams.

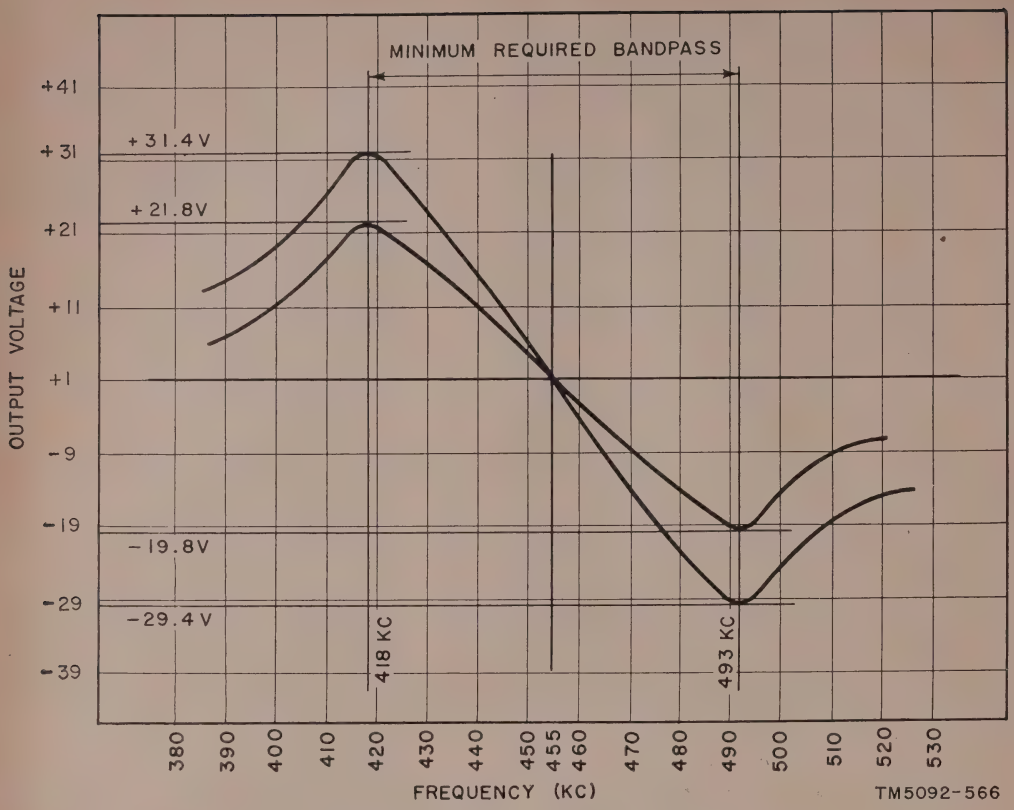


Figure 30. Radio Receiver R–394/U, discriminator response curves.

the receiver marked DISCR 5. A meter at this point can be used to measure either a fixed dc output (if a fixed frequency is applied to the receiver) or an audio output (if an fm signal is applied to the receiver).

57. First Audio Amplifier (fig. 31)

The first audio amplifier (V121) uses a shielded subminiature type 5678 tube. This stage amplifies the audio output of the discriminator. Input is applied through a de-emphasis network which consists of R121, R124, C121, C122, and C124. The de-emphasis network attenuates the higher audio frequencies. The grid circuit is returned through R122 and R128, to the junction between R144 and R145 in the squelch circuit (fig. 32). (Ground potential is at some point within R144.) R128 and C123 are a decoupling filter between the squelch and first audio circuits. It is from this point that bias is applied to both audio amplifiers. (Refer to par. 59 for squelch circuit operation.) Output from the first audio amplifier is coupled through C126 to a potentiometer (R127) which controls the voltage input to the audio power amplifier (V122). C122 is an audio coupling capacitor. C123 and R124 decouple the grid from audio-frequency (af) voltages developed in the squelch circuit or in the wiring. R123 and R124 shunt the filament to reduce its current to the desired value. Rf filament choke coil L112 prevents rf from getting into the filament circuit. Resistor R125 and capacitor C125 are the screen dropping resistor and screen grid bypass, respectively. R126 is the plate load resistor, across

which the amplified audio output is developed. Inverse feed-back from plate to grid is provided through C124. This capacitance offers a great impedance to the lower audio frequencies than to the higher audio frequencies. Therefore the high audio freqency feed-back is greater. This causes the high-frequency audio output of the amplifier to be attenuated much more than the low-frequency audio output. The high-frequency de-emphasis produced by the input circuit to the grid of this stage is increased by the action of this circuit.

58. Audio Power Amplifier (fig. 31)

The audio power amplifier (V122) uses a miniature type 6AK6 tube. This stage supplies audio power to a handset or to a loudspeaker in a control unit. The grid of this tube is connected to the movable contact of volume control R127 which has a slotted shaft for screwdriver adjustment. Adjustment of the control presets the audio output of the receiver. Output voltage is coupled through output matching transformer T121 to a speaker or handset. The grid return is through R127 and R128 to the junction of R144 and R145 in the squelch circuit. (Refer to paragraph 59 for squelch circuit operation.) When the SQUELCH disable switch is in the OFF position, this grid return point is grounded, thus allowing the two audio amplifier stages to operate regardless of the action of the squelch circuit. Higher plate and screen voltages are supplied to this stage than to the previous stages to obtain a high audio power output.

59. Squelch Circuit (fig. 32)

a. A squelch circuit is used to silence the rushing noise heard in an fm receiver when a signal is not being received. The squelch circuit used in this receiver, disables audio amplifier tubes V121 and V122 by biasing these tubes beyond cutoff during no signal input periods.

b. The audio output of the discriminator is applied to noise amplifier V123 through a high-pass filter consisting of C127 and R129 and C128 and R130. This two-section filter rejects audio frequencies (below 5,000 cps) but passes noise frequencies (5,000 to 15,000 cps). C129 couples the noise signals to the grid of V123. When a signal is being received, an agc voltage is developed at the grid of the fifth 455-kc if. amplifier (par. 53). This agc voltage is fed back to the grids of the first and second rf amplifiers

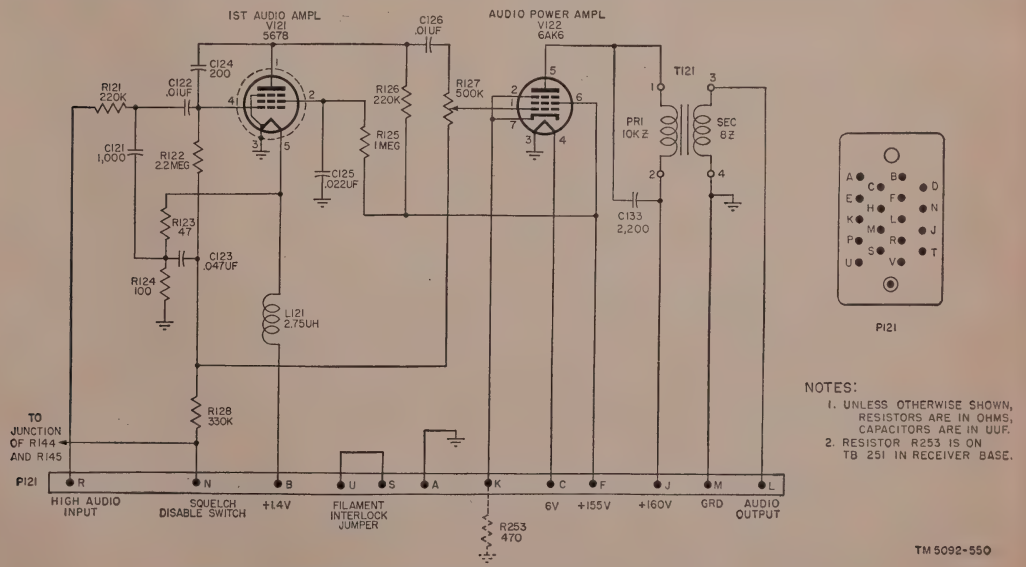


Figure 31. Radio Receiver R-394/U, first audio and audio power amplifiers.

and reduces their gain. The reduced gain of the rf amplifiers keeps the noise voltage down to a point below that necessary to operate the squelch circuit and squelch the receiver. When no signal is received, there is no agc voltage and the rf amplifiers operate at full gain. This increased amplification results in noise voltages large enough to operate the squelch circuit and squelch the receiver.

c. When the receiver is not squelched, there is a low positive voltage at the grid of V123. This voltage is obtained from a voltage divider consisting of R252 and R2408, which are in series with the 145-volt supply and another voltage divider consisting of R136 and CR121, in parallel with R2408. CR121 offers a low resistance to electron flow in the direction from ground through it to R136. Therefore, the positive voltage across this rectifier is low. It is this low positive voltage that is applied to the grid of V123 when no noise signal (or a very weak one) is applied. R2408, the SQUELCH control, may be varied (by panel control) to increase or decrease the value of this low positive voltage. The higher this positive voltage, the greater will be the noise voltage required to squelch the receiver and the lower will be the signal voltage required to unsquelch the receiver. This control, therefore, determines the squelch *threshold level.*

d. When no signal is being received, noise voltages are amplified sufficiently by the two rf amplifiers and the succeeding stages in the receiver to operate the squelch circuit. The noise voltage passes through the high-pass filter in the grid circuit of V123 and develops a negative bias at the grid of this tube. The amplified noise output at the plate of this tube is fed back through C131 to the junction of R136 and R135 in the grid circuit. CR121 shunt rectifies this ac signal, offering very little resistance to the positive half-cycles of signal which are applied across it from C131 but offering a very high resistance to the negative half-cycles. This results in a rectified negative voltage across CR121 which increases the negative bias on the grid of V123. With a high negative bias on V123, the dc plate current of this tube is greatly reduced and the dc plate voltage rises sharply.

e. Before the application of the noise signal to V123, V124 is biased to cutoff (through R147 and R139) by the —40-volt supply. The sharp rise in voltage at the plate of V123 raises the voltage at the grid of V124 and this tube now conducts. Conduction of V124 causes a drop in its plate voltage because of the voltage drop through R142.

f. A voltage divider exists between the plate of V124 (junction of R142 and R143) and the —40-volt supply. This divider consists of R143, R144, and R145. The values of these three resistors are such as to produce a very low negative voltage (with respect to ground) at the junction of R144 and R145 when the receiver is not squelched. It is this voltage that is applied to the grids of the two audio amplifiers, V121 and V122, and normally allows them to operate. However, the drop in plate voltage of V124 (*e* above) causes a drop in voltage at the junction of R144 and R145. This drop in voltage is sufficient to bias the two audio amplifiers beyond cutoff and all sound output from the receiver is squelched.

g. A drop in voltage is also produced at the grid of squelch clamp tube V125. This tube (which was normally conducting) is now biased close to cutoff. This raises its dc plate voltage. This rise in voltage occurs also across the voltage divider consisting of R146 and R147 and raises the voltage at the junction of these two resistors. This rise in voltage is applied through R139 to the grid of V124 to reinforce the action of V123 in raising the grid bias of V124 and causing it to conduct. This action assures a sufficient drop in voltage at the plate of V124 to squelch the two audio amplifiers. More positive squelch action is thus provided by this stage.

h. When a signal is received by the receiver, a considerable agc voltage is developed at the fifth 455-kc if. amplifier. The agc voltage is fed back to the two rf amplifiers and reduces their gain. Therefore, very low noise voltage is applied to the squelch circuit. The negative bias at the grid of V124 leaks off and the low positive voltage originally present before the application of the noise signal is again applied to the grid of this tube. The plate current increases and the plate voltage drops. The drop

in plate voltage produces a drop in the grid voltage of V124 and the plate current of this tube again is cut off. This causes a rise in its plate voltage and a rise in the voltage at the junction of R144 and R145. The rise in voltage at this junction is applied to the grids of the two audio amplifiers and allows them to conduct and operate. The rise in voltage at the plate of V124 also produces a rise in voltage at the grid of V125 (squelch clamp tube). This increases the plate current of this tube and causes a drop in its plate voltage. This drop in plate voltage produces (through R146 and R139) a further drop in the voltage at the grid of V124 and assures that this tube will remain cut off.

i. A squelch disable switch (S2402) is connected between the junction of R145 and R144 and ground. When the SQUELCH control is in its extreme clockwise position, this switch is closed. This action keeps the junction of R144 and R145 at ground potential regardless of any action of the squelch circuit. Therefore the audio amplifiers, which obtain their grid bias voltage from this point cannot be cut off and the receiver will not be squelched.

j. A muting circuit is provided through a connection from terminal T of P121. In some radio sets in which Radio Receiver R–394/U is used with an associated transmitter, it sometimes is desired that the receiver be muted (silenced) while the transmitter is being operated. To accomplish this, a +90-volt potential is supplied to terminal T of P121 from the transmitter. This potential, applied through a voltage divider consisting of R148, R139, and R147, raises the voltage at the grid of V124 and causes the tube to conduct. This produces a drop in voltage at the plate of V124 (and at the junction of R144 and R145) similar to the drop that occurs when squelch action (caused by noise) takes place. The audio amplifiers are therefore biased beyond cutoff and the receiver is muted (silenced).

60. Power Supplies (fig. 33)

a. The power supply referred to in this technical manual is the 115- or 230-volt ac Power Supply PP–846/U. This power supply is furnished with Radio Receiving Set AN/FRR–36. Below is a listing of this and other power supplies which are used with Radio Receiver R–394/U.

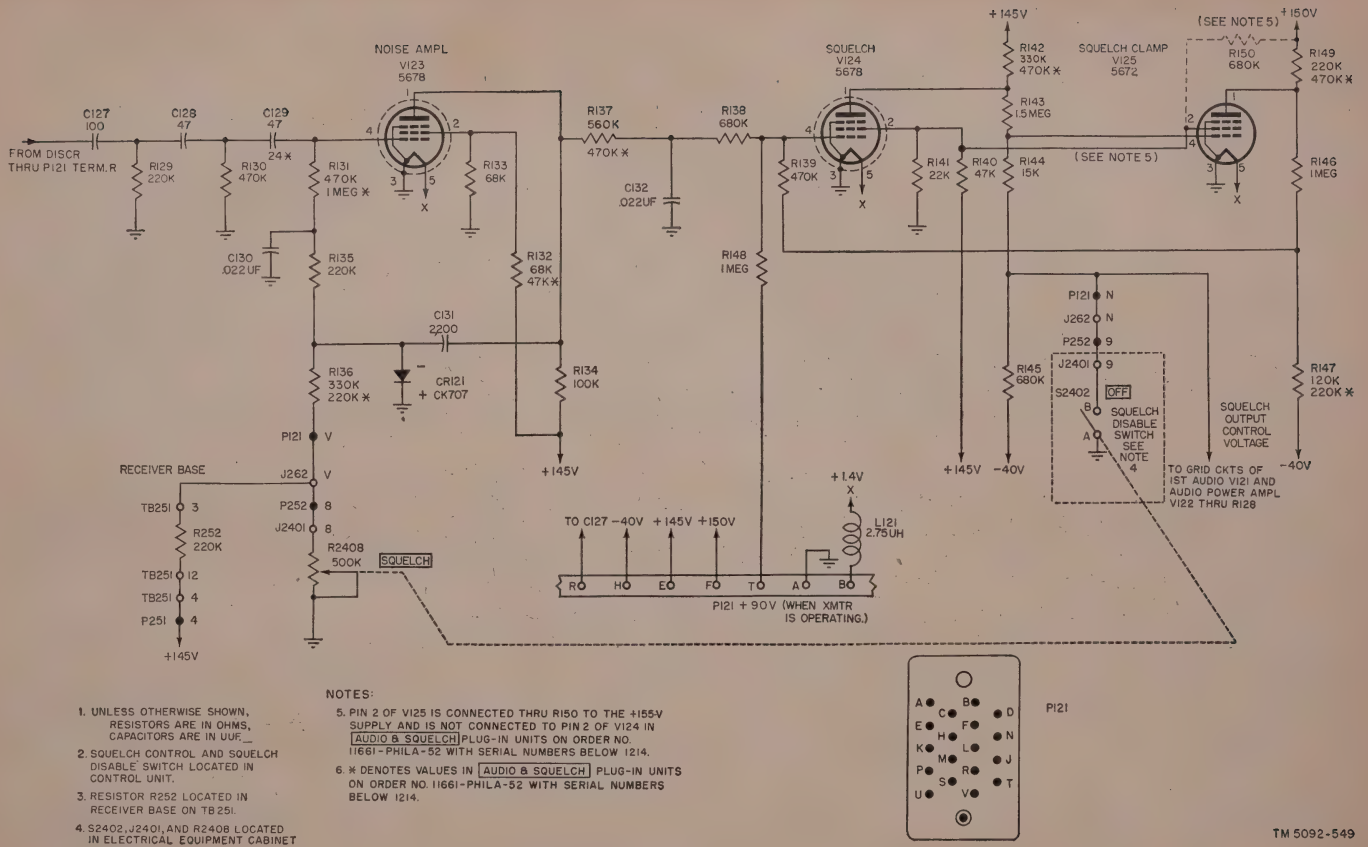
Power Supply PP–846/U (115- or 230-volt ac input).
Power Suply PP–867/U (24-volt dc input).
Power Supply PP–868/U (12-volt dc input).
Power Supply PP–869/U (6-volt dc input).

b. These four power supplies are interchangeable, the selection depending on the power source available and the radio set being used. Plug P251 in the receiver base connects to the jack in the power supply.

c. Power Supply PP–846/U is powered by a 115- or 230-volt ac, 50- to 65-cycle power source. The power transformer has two primary windings which are connected in parallel (properly phased) for 115-volt ac use, and in series (properly phased) for 230-volt ac use. The 1.4 volt dc filament power is rectified and regulated by three selenium rectifiers. The plate supply is rectified (full-wave) by selenium rectifiers, connected in a bridge circuit. The negative 40-volt dc supply is rectified by a selenium rectifier connected for half-wave operation. The two tubes in the receiver with 6.3-volt filaments are supplied by a 6.3-volt ac winding on the power transformer. This winding also supplies power to the heater in crystal oven E31.

61. Relay Adaptation in Radio Receiver R–394/U

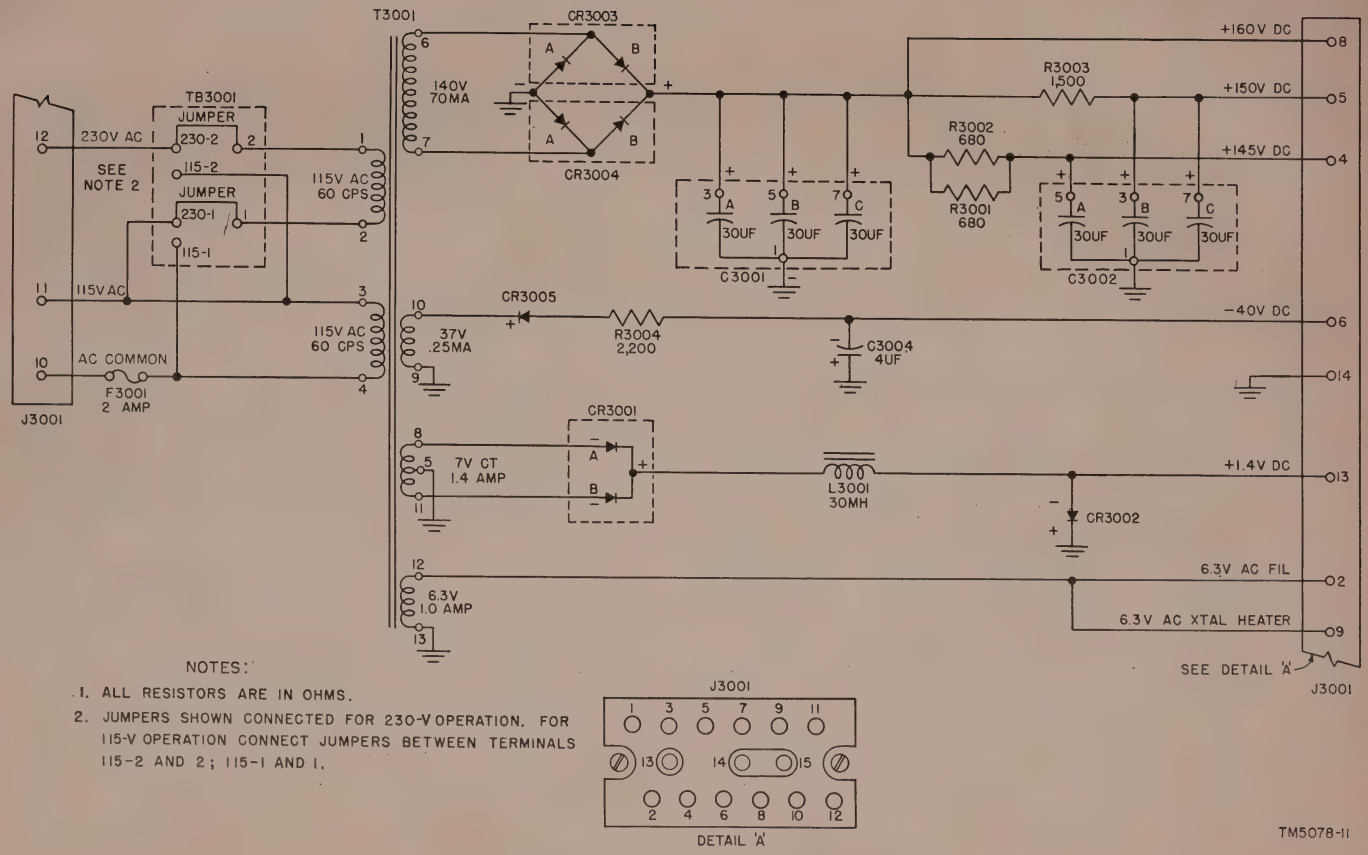
Radio Receiver R–394/U normally employs a 470-ohm resistor, R253 (fig. 34), as the cathode bias resistance of audio power amplifier V122. An alternate circuit is through relay K271, which has a 500-ohm coil. It is substituted for the cathode bias resistance (R253) of this stage when the jumper is removed from terminals 9 and 10 of TB251 and connected across terminals 10 and 11 (figs. 35 and 76). This relay in Radio Receiver R–394/U can be used to control a transmitter for retransmission, or it can be used as a signaling device, which notifies the operator when a signal is being received. The relay coil is bypassed for audio with a 25-microfarad (μf) capacitor (C271) so that degeneration in the cathode circuit will not occur. Relay K271 is energized



NOTES:

1. UNLESS OTHERWISE SHOWN, RESISTORS ARE IN OHMS, CAPACITORS ARE IN UUF.
2. SQUELCH CONTROL AND SQUELCH DISABLE SWITCH LOCATED IN CONTROL UNIT.
3. RESISTOR R252 LOCATED IN RECEIVER BASE ON TB251.
4. S2402, J2401, AND R2408 LOCATED IN ELECTRICAL EQUIPMENT CABINET CY-1150/U.
5. PIN 2 OF V125 IS CONNECTED THRU R150 TO THE +155V SUPPLY AND IS NOT CONNECTED TO PIN 2 OF V124 IN AUDIO & SQUELCH PLUG-IN UNITS ON ORDER NO. 11661-PHILA-52 WITH SERIAL NUMBERS BELOW 1214.
6. * DENOTES VALUES IN AUDIO & SQUELCH PLUG-IN UNITS ON ORDER NO. 11661-PHILA-52 WITH SERIAL NUMBERS BELOW 1214.

Figure 32. Radio Receiver R-394/U, squelch circuit.



NOTES:

1. ALL RESISTORS ARE IN OHMS.
2. JUMPERS SHOWN CONNECTED FOR 230-V OPERATION. FOR 115-V OPERATION CONNECT JUMPERS BETWEEN TERMINALS 115-2 AND 2; 115-1 AND 1.

Figure 33. Power Supply PP-846/U, schematic diagram.

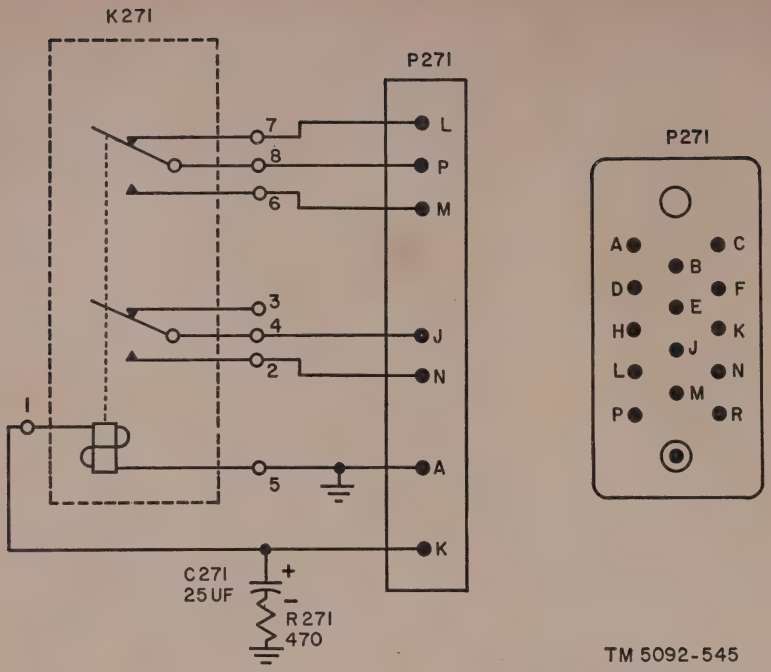


Figure 34. Radio Receiver R–394/U, schematic diagram of RELAY plug-in unit.

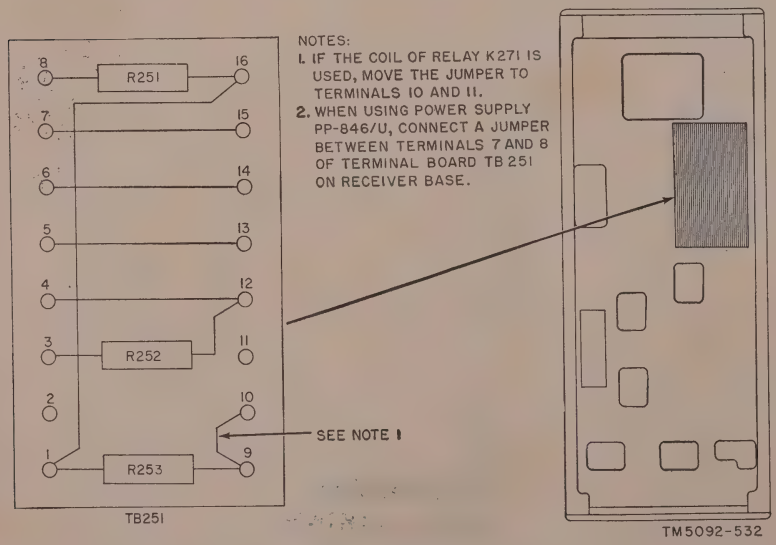

NOTES:
1. IF THE COIL OF RELAY K271 IS USED, MOVE THE JUMPER TO TERMINALS 10 AND 11.
2. WHEN USING POWER SUPPLY PP-846/U, CONNECT A JUMPER BETWEEN TERMINALS 7 AND 8 OF TERMINAL BOARD TB 251 ON RECEIVER BASE.
R251
R252
R253
SEE NOTE 1
TB251
TM5092-532

Figure 35. Radio Receiver R–394/U, showing jumper connections on RELAY plug-in unit.

K4OS/WB4RHH
CHES. WATKINS
P. O. BOX 3288
FT. PIERCE, FLA. 33450

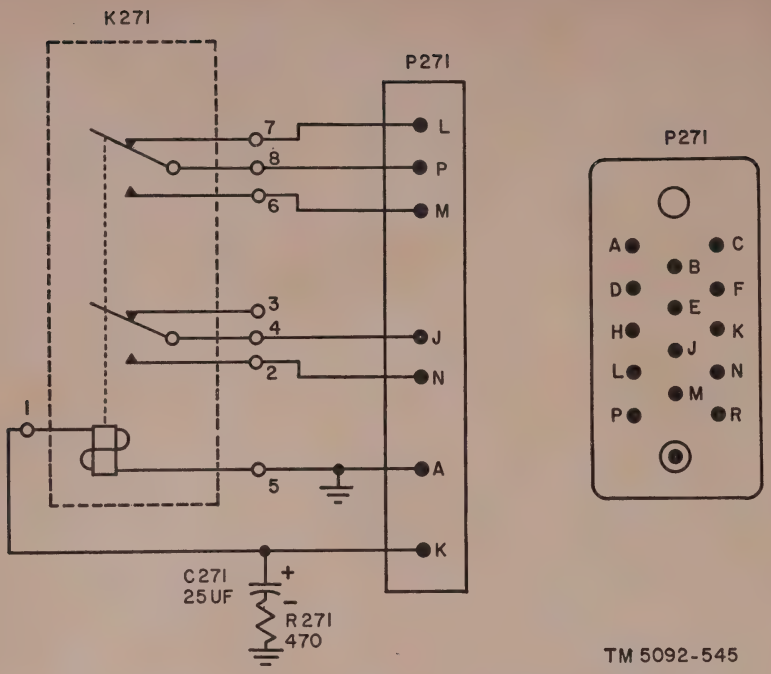


Figure 34. Radio Receiver R–394/U, schematic diagram of RELAY plug-in unit.

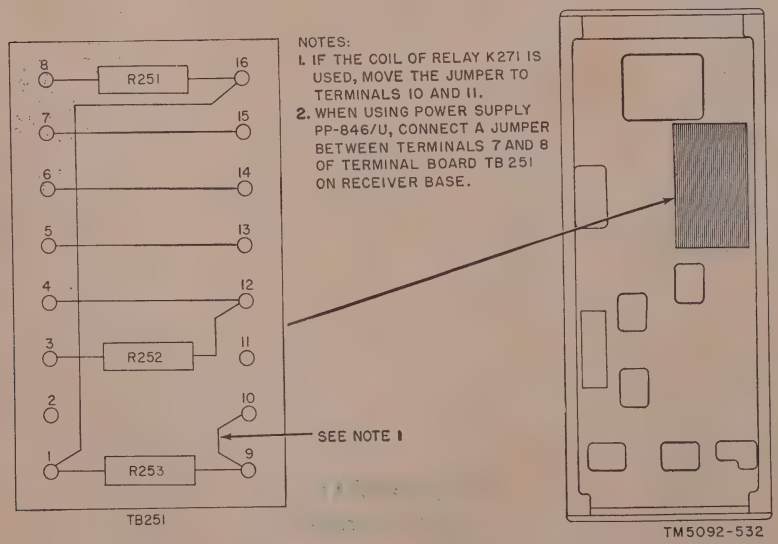
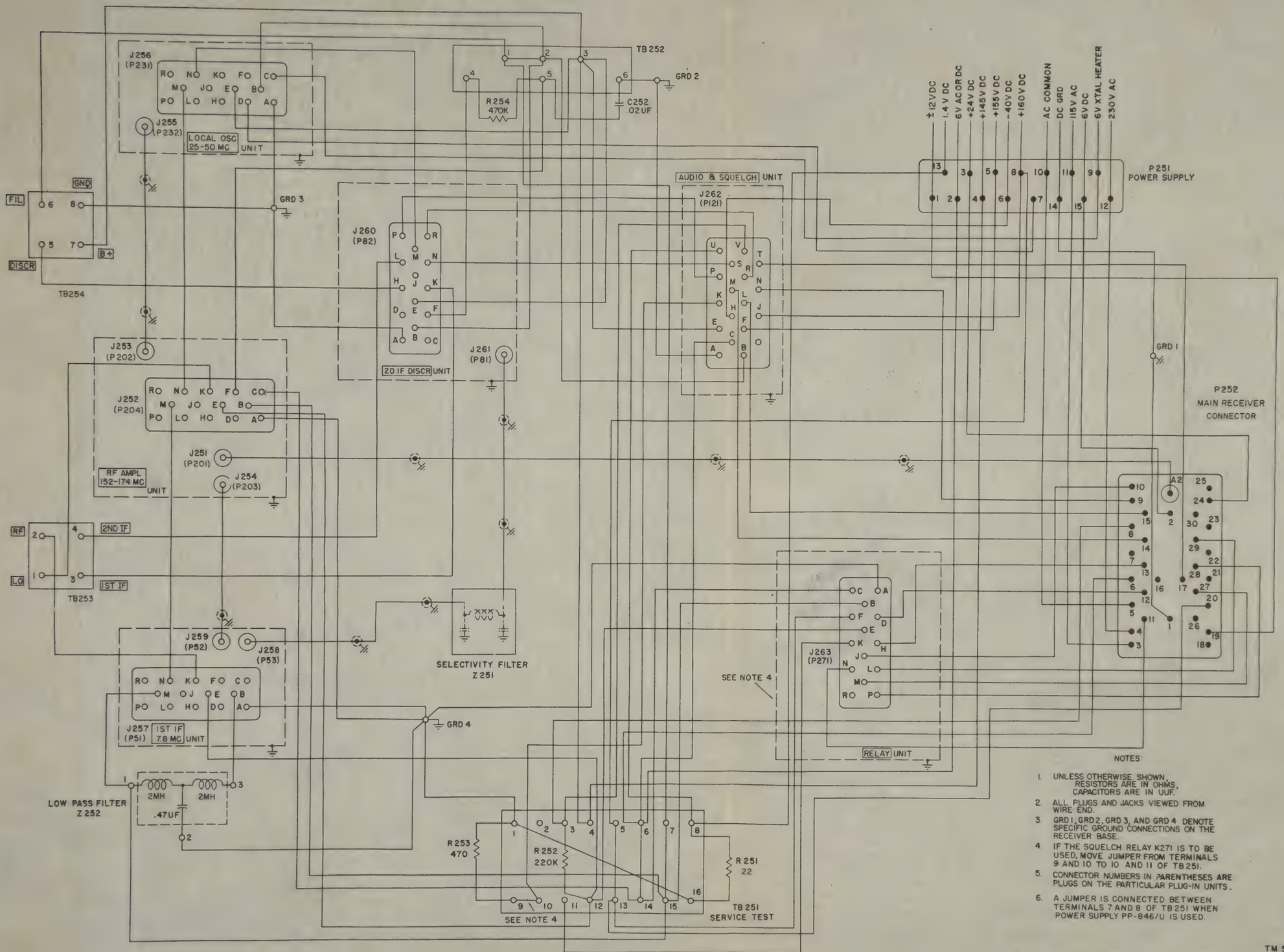


Figure 35. Radio Receiver R–394/U, showing jumper connections on RELAY plug-in unit.



NOTES:

1. UNLESS OTHERWISE SHOWN, RESISTORS ARE IN OHMS, CAPACITORS ARE IN UUF.
2. ALL PLUGS AND JACKS VIEWED FROM WIRE END.
3. GRD 1, GRD 2, GRD 3, AND GRD 4 DENOTE SPECIFIC GROUND CONNECTIONS ON THE RECEIVER BASE.
4. IF THE SQUELCH RELAY K271 IS TO BE USED, MOVE JUMPER FROM TERMINALS 9 AND 10 TO 10 AND 11 OF TB 251.
5. CONNECTOR NUMBERS IN PARENTHESES ARE PLUGS ON THE PARTICULAR PLUG-IN UNITS.
6. A JUMPER IS CONNECTED BETWEEN TERMINALS 7 AND 8 OF TB 251 WHEN POWER SUPPLY PP-846/U IS USED.

TM 5092-534

Figure 36. Radio Receiver R-394/U, schematic diagram of receiver base

when the audio power amplifier, (V122 draws more than 9 milliamperes (ma) of current.)

62. Receiver Base
(fig. 36)

a. General. The receiver base of Radio Receiver R–394/U contains six connectors which accommodate the various plug-in units. It also contains selectivity filter Z251, filament filter Z252, main receiver connector P252, power supply connector P251, eight test jacks which terminate at the front of the receiver, and two terminal boards.

b. Plug P252. This plug provides a connection from the receiver to the radio set case. Various voltages and signals are routed through this plug, to the SQUELCH control, audio output, antenna input, squelch relay contacts, and power input to the power supply.

c. Plug P251. This plug provides a connection from the power supply to the receiver. It mates with each of the four power supplies that can be used with this receiver. A small handle on this plug aids connection and disconnection.

d. Filters Z251 and Z252. The if. selectivity filter Z251 is connected between the second mixer (V52) and the first 455-kc if. amplifier (V81). Filament voltage is applied to the 1ST IF. 7.8 MC plug-in unit through filament filter Z252. Both filters are wired into the receiver base. Selectivity filter Z251 is referred to in paragraph 48. Filament filter Z252 prevents stray rf voltage from entering the filaments of V51, V52, and V53.

e. Terminal Board TB251 and TB252. These terminal boards mount four resistors and one capacitor. A jumper change involving RELAY plug-in unit adaptation is made on TB251. Resistor R254 and capacitor C252 (on TB252) are part of the agc decoupling network. Resistor R251 (on TB251) shunts and limits the 1.4-volt filament voltage. Resistor R252 (on TB251) in series with the SQUELCH control (in control unit), and resistor R253 (on TB25 is the cathode bias resistor for audio power amplifier V122.

63. Electrical Equipment Cabinet CY–1150/U
(fig. 37)

a. This case is a compact unit which conta a typical control circuit and a loudspeaker operatio nof Radio Receiver R–394/U. The co plete assembly is Radio Set AN/FRR–36. T particular case (figs. 3 and 14) houses the ceiver and power supply.

b. A blastproof loudspeaker, LS2401, loca at the front of the case, is used for convert the audio output voltage into audible sour VOLUME control S2401A is a wafer swi wired with resistors R2401 through R2406 operates as a four-position attenuator cont Maximum volume is obtained with this cont fully clockwise. In the extreme counterclo wise position, switch S2401B (ganged S2401A) breaks the power circuit of the ra set. POWER indicator lamp I2401 lights wh the power is turned on Resistor R2407 lim current through this lamp to the desired val

c. SQUELCH control R2408 and squelch able switch S2402 connect to the AUDIO SQUELCH plug-in unit through connec J2401 and P252 (main receiver connecto When S2402 is closed, the audio grid circu are grounded through this switch and squelch circuit is disabled.

d. Connector J2401 mates with the main ceiver connector P252 in the receiver. Ter nal board TB2401 is located at the rear of El trical Equipment Cabinet CY–1150/U and used as junction points for power and squelch relay contacts. The antenna is c nected to the radio set through coaxial c nectors J2402, P2401 and A2 on J2401.

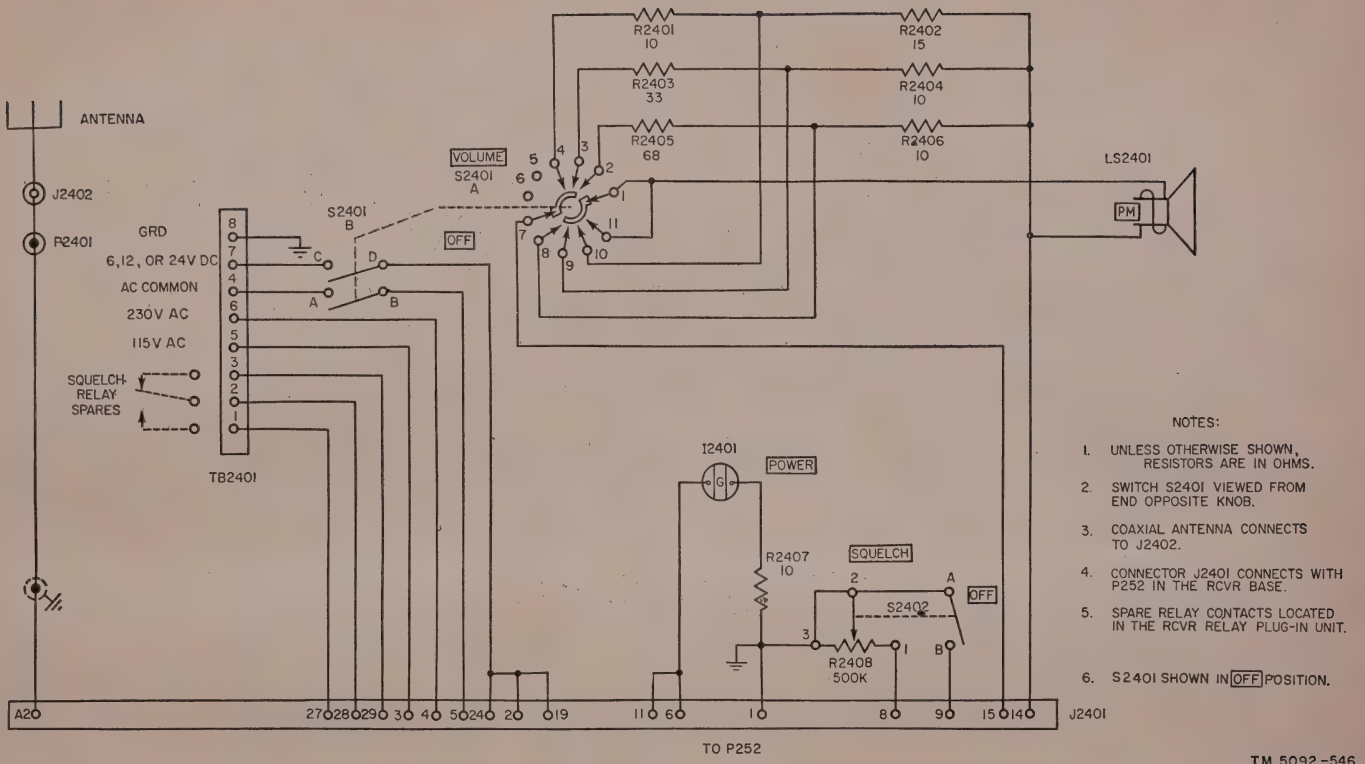


Figure 37. Electrical Equipment Cabinet CY–1150/U, control circuit.

CHAPTER 5
FIELD MAINTENANCE

Section I. TROUBLESHOOTING AT FIELD MAINTENANCE LEVEL

Warning: When an external voltage is applied to the receiver, there is a possibility of electrical shock if contact is made with certain terminals or wires in the set. When used with Power Supply PP–846/U, the main receiver connector P252 and the power supply connector P251 have as much as 230-volt ac on their terminals. The dc power supplies have voltages as high as 150-volts dc.

64. Troubleshooting Procedures

The procedure in servicing a defective radio set is to sectionalize the fault. Sectionalization means tracing the fault to the plug-in unit or receiver base, whichever contains the defect. The second step is to localize the fault. Localization means tracing the fault to the defective part responsible for the abnormal condition. Some faults such as burned out resistors and shorted transformers often can be located by sight, smell, and hearing. The majority of the faults, however, must be localized by checking voltage and resistance.

a. System Sectionalization. System sectionalization is described in the instruction books of the radio systems in which Radio Receiver R–394/U is used.

b. Component Sectionalization and Localization. The tests listed below aid in isolating the source of trouble. To be effective, the procedure should be followed in the order given. Remember that servicing procedure should cause no further damage to the receiver. Trouble should be localized to a particular plug-in unit. Then the trouble should be isolated within the plug-in unit by appropriate voltage and resistance checks. The service procedure is summarized as follows:

(1) *Visual checks.* The purpose of visual checks is to locate any visible trouble. Through this inspection the technician frequently will discover the trouble, or clues to the trouble. These checks are valuable in avoiding additional damage to the receiver and in eliminating future failures.

(2) *Input resistance measurements.* These measurements (pars. 69, 70, and 71) prevent further damage to the receiver from possible short circuits. Since these tests give an indication of the condition of bypass capacitors, their function is more than preventive.

(3) *Operational test.* The operational test (par. 72) is important because it frequently indicates the general location of trouble. In many instances the information gained will determine the exact nature of the fault. To utilize this information fully, all symptoms must be interpreted in relation to one another.

(4) *Troubleshooting chart.* The trouble symptoms listed in this chart (par. 74) will aid in localizing trouble.

(5) *Signal substitution.* The principal advantage of the signal substitution method (par. 76) is that it usually enables the repairman to localize a trouble accurately and quickly to a given stage when the general location of the trouble is not immediately evident from the above tests.

(6) *Intermittents.* In all these tests the possibility of intermittents should not be overlooked. If present, this type of trouble may be made to appear by tapping or jarring the set. It is possible that the trouble is not in the receiver itself but in the installation, or the

trouble may be due to external conditions. In this event, test the installation, if possible.

65. Troubleshooting Data

Take advantage of the material supplied in this technical manual. It will help in the rapid location of faults. Consult the following figures:

Fig. No.	Title
8 through 12	Radio Receiver R–394/U, tube locations.
37	Control circuit schematic diagram of Electrical Equipment Cabinet CY–1150/U.
43	Radio Receiver R–394/U, B+ voltage distribution diagram.
46	Radio Receiver R–394/U, RF AMPL 152–174 MC plug-in unit, tube socket voltage and resistance measurements.
47	Radio Receiver R–394/U, LOCAL OSC 152–174 MC plug-in unit, tube socket voltage and resistance measurements.
48	Radio Receiver R–394/U, LOCAL OSC 152–174 MC, terminal board voltage and resistance measurements.
49	Radio Receiver R–394/U, 1ST IF 7.8 MC plug-in unit, tube socket voltage and resistance measurements.
50	Radio Receiver R–394/U, 2ND IF DISCR plug-in unit, tube socket voltage and resistance measurements.
51	Radio Receiver R–394/U, 2ND IF DISCR plug-in unit, terminal board voltage and resistance measurements.
52 or 53	Radio Receiver R–394/U, AUDIO & SQUELCH plug-in unit, tube socket voltage and resistance measurements.
54 or 55	Radio Receiver R–394/U, AUDIO & SQUELCH plug-in unit, terminal board voltage and resistance measurements.
56	Radio Receiver R–394/U, RELAY plug-in unit, voltage and resistance measurements.
36	Radio Receiver R–394/U, base, schematic diagram.
57	Radio Receiver R–394/U, base, voltage and resistance measurement.
58	Radio Receiver R–394/U, base, bottom view.
59	Radio Receiver R–394/U, RF AMPL 152–174 MC plug-in unit, top view.
60	Radio Receiver R–394/U, RF AMPL 152–174 MC plug-in unit, bottom view.
61	Radio Receiver R–394/U, LOCAL OSC 152–174 MC plug-in unit, top view.
62	Radio Receiver R–394/U, LOCAL OSC 152–174 MC plug-in unit, bottom view.
63	Radio Receiver R–394/U, 1ST IF 7.8 MC plug-in unit, top view.
64	Radio Receiver R–394/U, 1ST IF 7.8 MC plug-in unit, bottom view.
65	Radio Receiver R–394/U, 2ND IF DISCR plug-in unit, top view.
66	Radio Receiver R–394/U, 2ND IF DISCR plug-in unit, bottom view.
67	Radio Receiver R–394/U, AUDIO & SQUELCH plug-in unit, top view.
68	Radio Receiver R–394/U, AUDIO & SQUELCH plug-in unit, bottom view.
69	Radio Receiver R–394/U, RELAY plug-in unit, top view.
70	Radio Receiver R–394/U, RELAY plug-in unit, bottom view.
44	Radio Receiver R–394/U, filament circuits schematic diagram.
78	Radio Receiver R–394/U, schematic diagram.

66. Test Equipment Required for Troubleshooting

The test equipment required for troubleshooting Radio Receiver R–394/U is listed below. The technical manuals associated with the test equipment are also listed.

Test equipment	Publication
Signal Generators:	
Signal Generator SG–3/U or equal.	
RF Signal Generator Set AN/URM–25, or Signal Generator TS–588A/U.	TM–5551. TM 11–5018.
Electronic Multimeters:	
Electronic Multimeter ME–6A/U, or ME–6B/U, or equal.	TM 11–5549 or TM 11–5549A.
Electronic Multimeter TS–505/U, or equal.	TM 11–5511.
Output Meter TS–585A/U or TS–585B/U.	TM 11–5017/TO 16–35TS585–5.
Frequency Meter TS–174B/U.	TM 11–5044/TO 16–35TS174–5.
Audio Oscillator TS–382A/U.	TM 11–2684A.
Spectrum Analyzer TS–723/U.	
Tube Tester I–177, or I–177–A, and Tube Socket Adapter Kit MX–949/U.	TM 11–2627/TO 16–40I177–5. TB 11–2627–2/TO 16–40I177–6.

67. General Precautions

Observe the following precautions when servicing the receiver:

a. Be careful when removing the power supply cover plate or the receiver base bottom cover; voltages in excess of 230 volts may be present.

b. When removing the power supply, carefully remove the power supply plug P251 so that no damage to the plug contacts or wiring occurs.

c. When removing the subminiature tubes, be extremely careful because the pins are very tiny and fragile. Do not tip or twist these tubes, but lift them straight upward away from the tube socket. When replacing them, be sure the red dots on the chassis and tube line up so that the proper connections are maintained.

d. Do not strip or damage the screws or Airloc fasteners used in the receiver. Always replace the required lockwashers when a part is removed and replaced.

e. Careless replacement of parts can be a source of additional faults. Take the following precautions when replacing a part in the receiver:

(1) Before a part is unsoldered and removed, note the position of the leads. If the part has numerous leads or terminals, tag each wire or make a pencil diagram of the parts and its connections, so that the replacement part will be wired correctly.

(2) Be careful not to damage other parts or wires when it is necessary to remove a part.

(3) Do not allow drops of solder to fall into the receiver. They may cause short circuits.

(4) A carelessly soldered connection may create a new defect. It is important to make well soldered joints, because a poorly soldered joint is one of the most difficult faults to detect. Most of the parts are very small, and their leads are short. Solder connections as rapidly as possible to prevent overheating of the parts. However, be sure that the soldered joint is a good one.

(5) When a part is replaced in the rf or if. circuits, it must be positioned exactly as the original. A part which has the same electrical value but a different physical size or location may cause trouble in hf or very-high frequency (vhf) circuits. Give particular attention to proper ground when replacing a part. Use the same ground point as the original wiring. Failure to observe these directions may result in decreased gain or possibly in oscillation of the circuit caused by regeneration.

(6) Do not disturb the setting of audio gain control R127 unless this part is being replaced. If this is so, adjust R127 as prescribed in paragraph 93. If necessary to adjust or test R127 when making af tests, mark its setting and reestablish this setting at the conclusion of the test, or adjust it as prescribed.

(7) When removing or replacing any *pluck-out* items such as tubes, crystal oven, crystals, plugs, or plug-in units, perform this function carefully, and be sure they are alined properly when being replaced. This receiver and its parts are small and, in many instances, more fragile than parts used in ordinary radio equipment.

68. Test Installation of Radio Receiver R–394/U

Three patch cords are authorized for use in testing Radio Receiver R–394/U. They are authorized in the Supply Catalogs SIG 7 & 8 for the radio sets that include Radio Receiver R–394/U and should be requisitioned through normal supply channels. The patch cords are listed in the chart below:

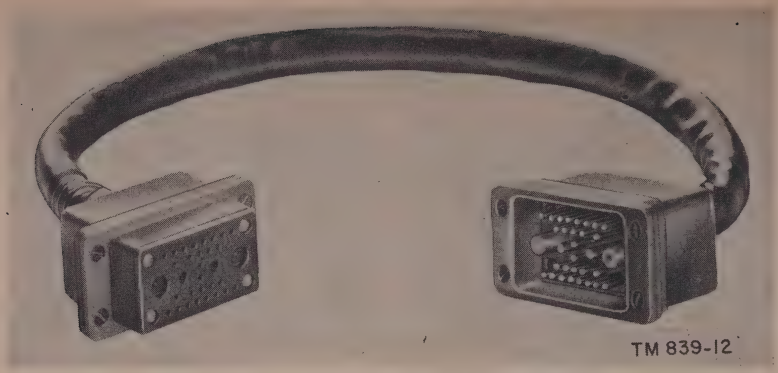


Figure 38. Electrical Special Purpose Cable Assembly CX–2371/U (patch cord).

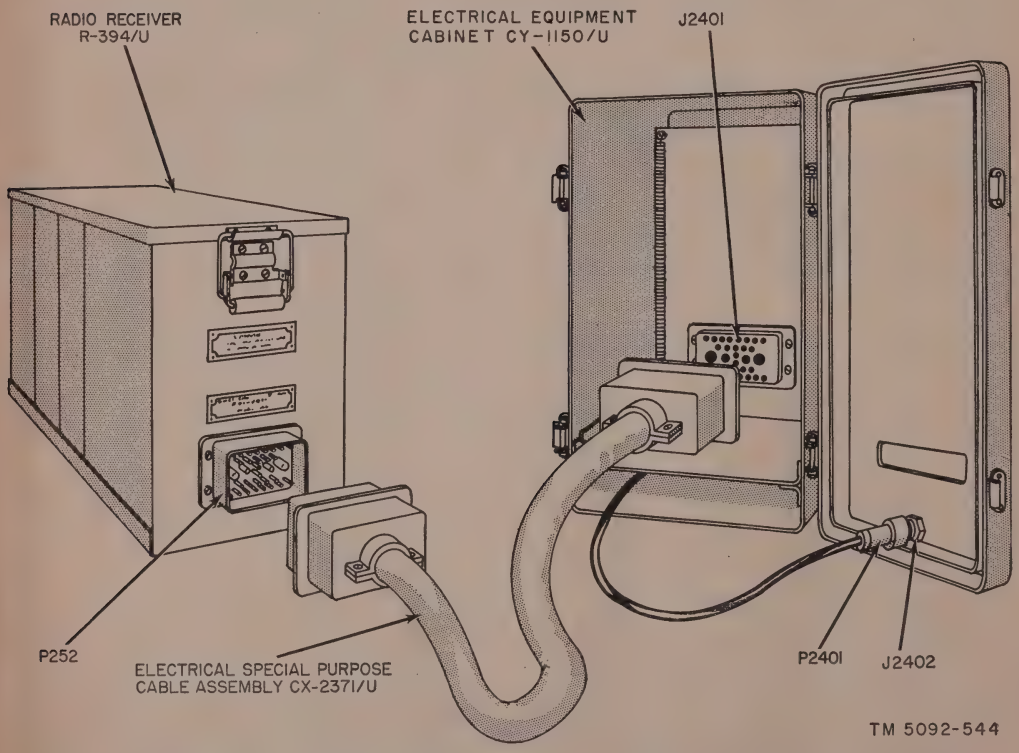


Figure 39. Radio Receiver R–394/U, patch cord connection to Electrical Equipment Cabinet CY–1150/U.

Description	Stock No.	Function	Authorized echelons
Electrical Special Purpose Cable Assembly CX–2371/U (figs. 38 and 39).	3E4002.75	Connects receiver to its case.	All.
Electrical Special Purpose Cable Assembly CX–2511/U.	3E5999A–62	Connects all plug-in units except the AUDIO & SQUELCH plug-in unit to the receiver chassis.	Field maintenance echelons.
Electrical special purpose cable assembly.	3E4002.94	Connects AUDIO & SQUELCH plug-in unit to receiver chassis.	Field maintenance echelons.

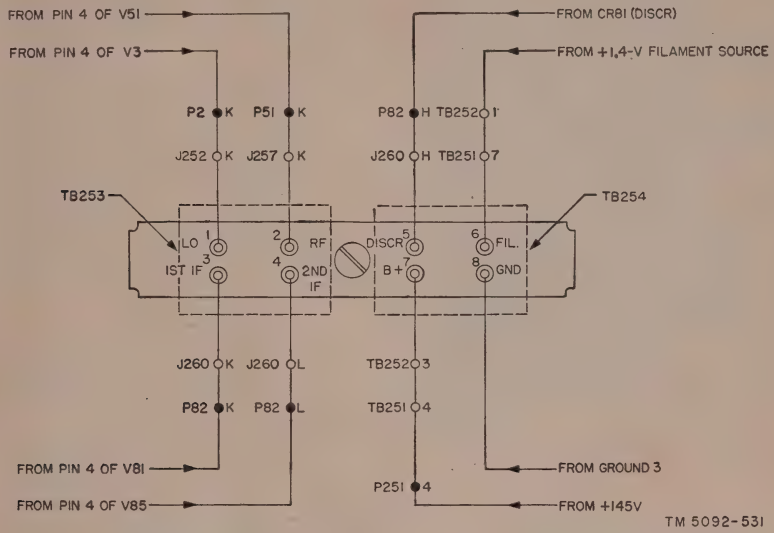


Figure 40. Radio Receiver R–394/U, front panel test points.

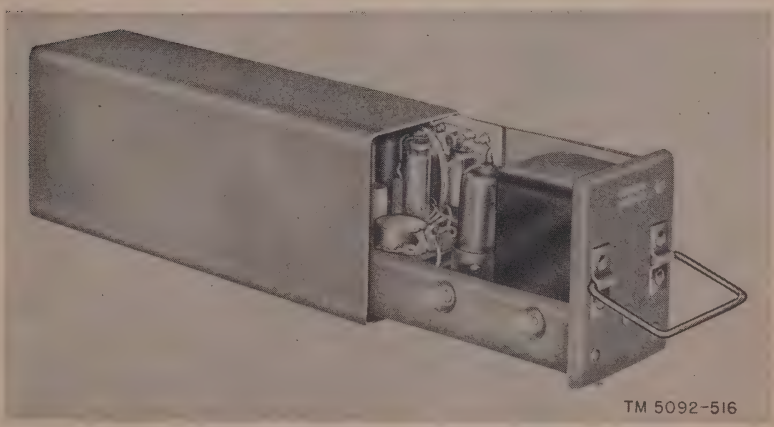


Figure 41. Plug-in unit with cover partially removed.

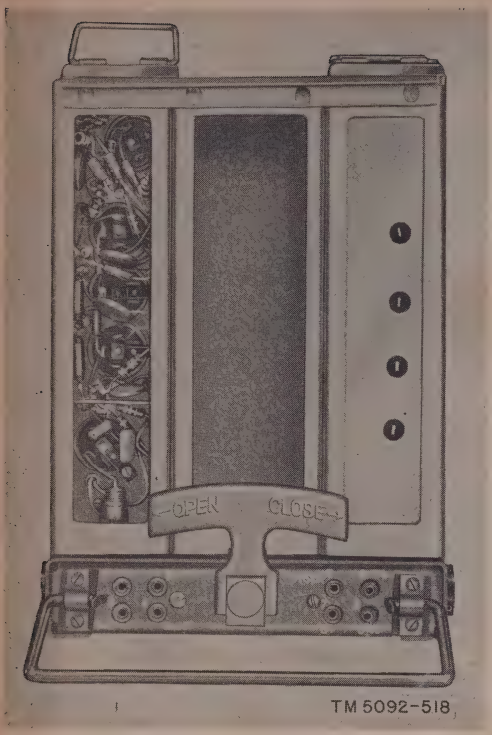


Figure 42. Radio Receiver R–394/U, front view showing accessibility of plug-in units when installed.

a. Installation of Power Supply.

(1) If a 115-volt or 230-volt ac source is available, use Power Supply PP–846/U. If a 115-volt source is used, connect wire jumpers between terminal 1 and 115–1 and between 2 and 115–2 of TB3001 in the power supply. If a 230-volt source is used, connect wire jumpers between terminals 1 and 230–1 and between 2 and 230–2 of TB3001 in the power supply. Install the power supply in the power supply compartment of the receiver (fig. 5) and connect P251 to the power supply connector. When Power Supply PP–846/U is used, connect a jumper between terminals 7 and 8 of terminal board TB251.

(2) If a 6-volt source of power is used, install Power Supply PP–869/U in the receiver and connect P251 to the power supply connector.

(3) If a 12-volt source of power is used, install Power Supply PP–868/U in the receiver and connect P251 to the power supply connector.

(4) If a 24-volt source of power is used, install Power Supply PP–867/U in the receiver and connect P251 to the power supply connector.

b. Connections to Electrical Equipment Cabinet CY–1150/U. Connect the patch cord between P252 of the receiver and J2401 of the cabinet (fig. 39).

(1) When Power Supply PP–846/U is used with a 115-volt power source, connect the input power cord to terminals 4 and 5 of TB2401. When a 230-volt source is used, connect the input power cord to terminals 4 and 6 of TB2401.

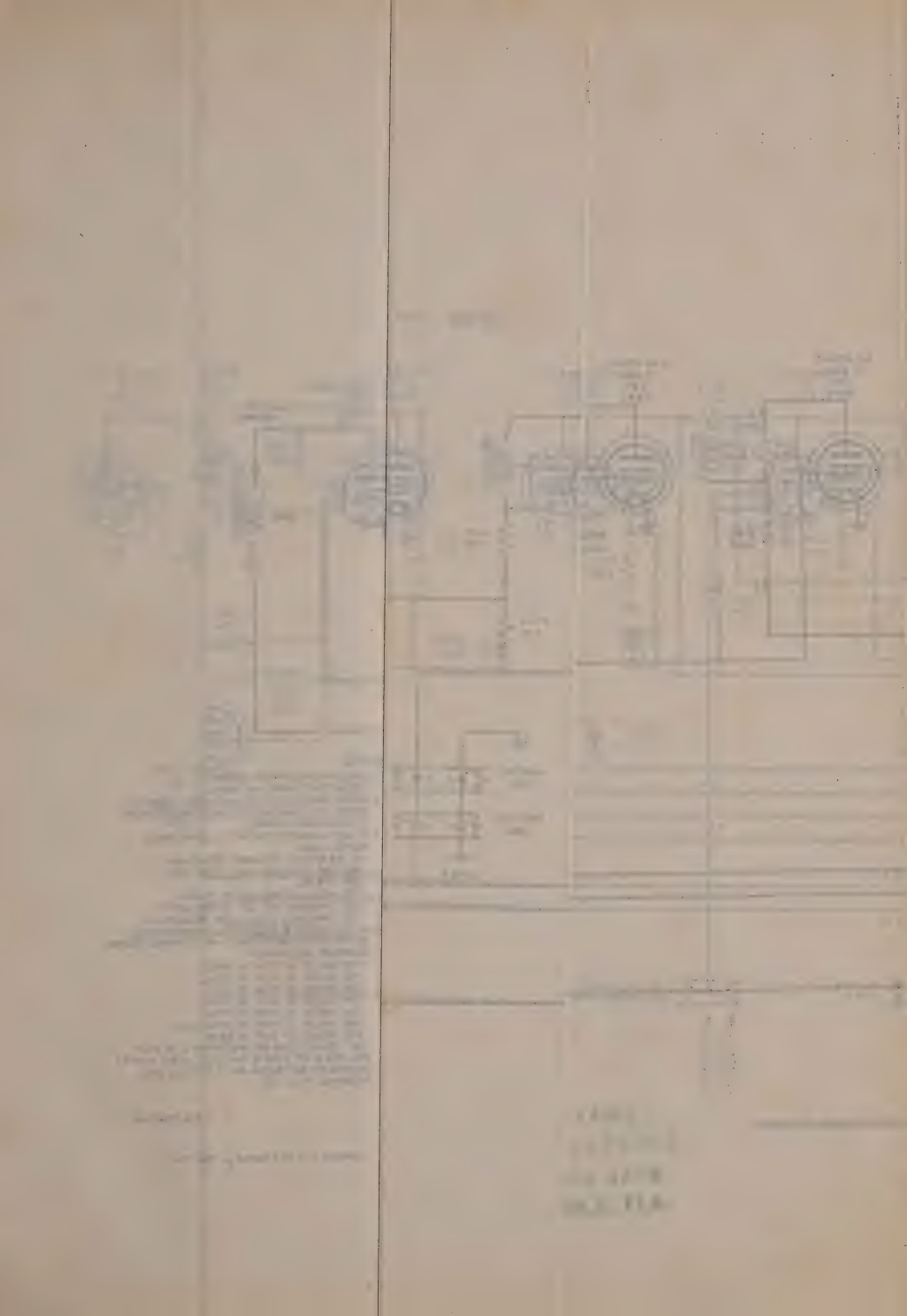
(2) When Power Supply PP–867/U, PP–868/U, or PP–869/U is used, connect the input power cord to terminals 7 and 8 of TB2401.

(3) Connect the other end of the power cord to the power source (230-volt ac, 115-volt ac, or 6-, 12-, or 24-volt dc).

69. Checking for B+ Shorts

a. A B+ short can disable the entire receiver, or it can result in erratic operation. Defective capacitors can at times be difficult to detect by an ohmmeter check. Sometimes they become *leaky* which means that they allow direct current to pass through them. Reference to the B+ distribution schematic diagram (fig. 43) and to voltage and resistance illustrations (figs. 45 through 57) will aid in locating B+ shorts.

b. After determining that the trouble is not in the power supply, sectionalize the trouble to the receiver base or to one of the plug-in units. A B+ short may not necessarily blow a power supply fuse, but it may cause certain resistors to become overheated. If the B+ voltage, as measured at the front panel test point marked B+, is quite low, pull out each plug-in unit, one at a time, while watching the voltage reading at this test point. Removing one plug-in unit will unload the power supply because the filament circuit is opened and the B+ will rise slightly. If one of the plug-in units contains a B+ short



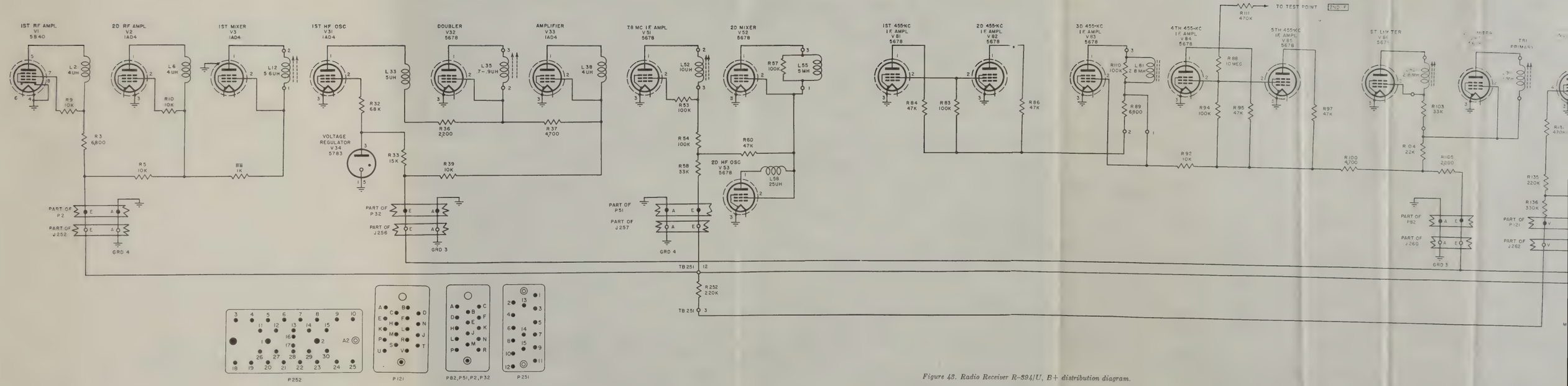
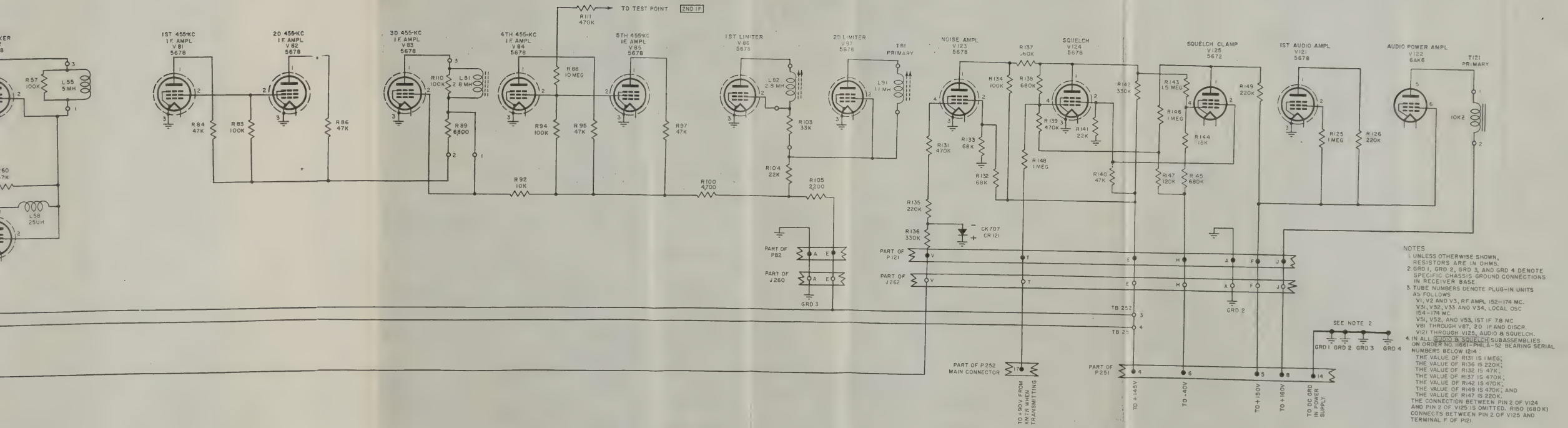


Figure 43. Radio Receiver R-894/U, B+ distribution diagram.



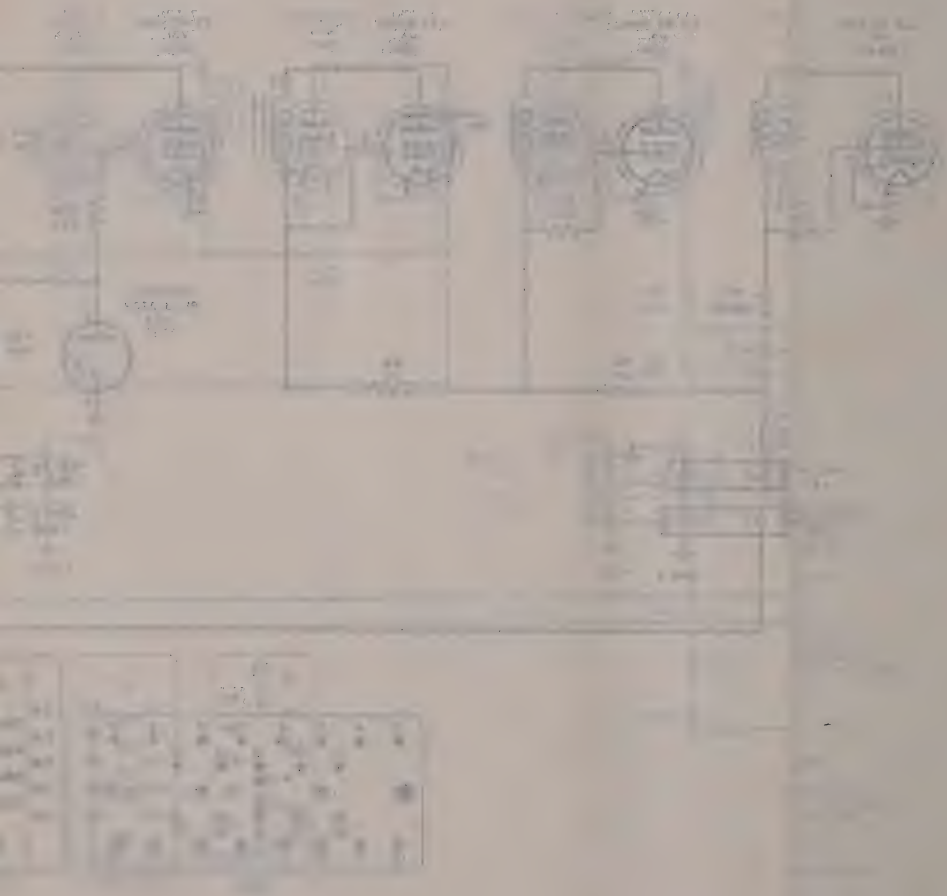
NOTES

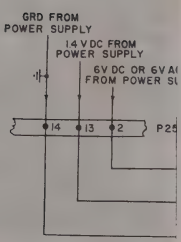
1. UNLESS OTHERWISE SHOWN, RESISTORS ARE IN OHMS.
2. GRD 1, GRD 2, GRD 3, AND GRD 4 DENOTE SPECIFIC CHASSIS GROUND CONNECTIONS IN RECEIVER BASE.
3. TUBE NUMBERS DENOTE PLUG-IN UNITS AS FOLLOWS
   V1, V2 AND V3, RF AMPL 152–174 MC.
   V31, V32, V33 AND V34, LOCAL OSC 154–174 MC.
   V51, V52, AND V53, IST IF 7.8 MC
   V81 THROUGH V87, 2D IF AND DISCR.
   V121 THROUGH V125, AUDIO & SQUELCH.
4. IN ALL AUDIO & SQUELCH SUBASSEMBLIES ON ORDER NO. 11661-PHILA-52 BEARING SERIAL NUMBERS BELOW 1214:
   THE VALUE OF R131 IS 1 MEG;
   THE VALUE OF R136 IS 220K;
   THE VALUE OF R132 IS 47K;
   THE VALUE OF R137 IS 470K;
   THE VALUE OF R142 IS 470K;
   THE VALUE OF R149 IS 470K; AND
   THE VALUE OF R147 IS 220K.
   THE CONNECTION BETWEEN PIN 2 OF V124 AND PIN 2 OF V125 IS OMITTED. R150 (680 K) CONNECTS BETWEEN PIN 2 OF V125 AND TERMINAL F OF P121.

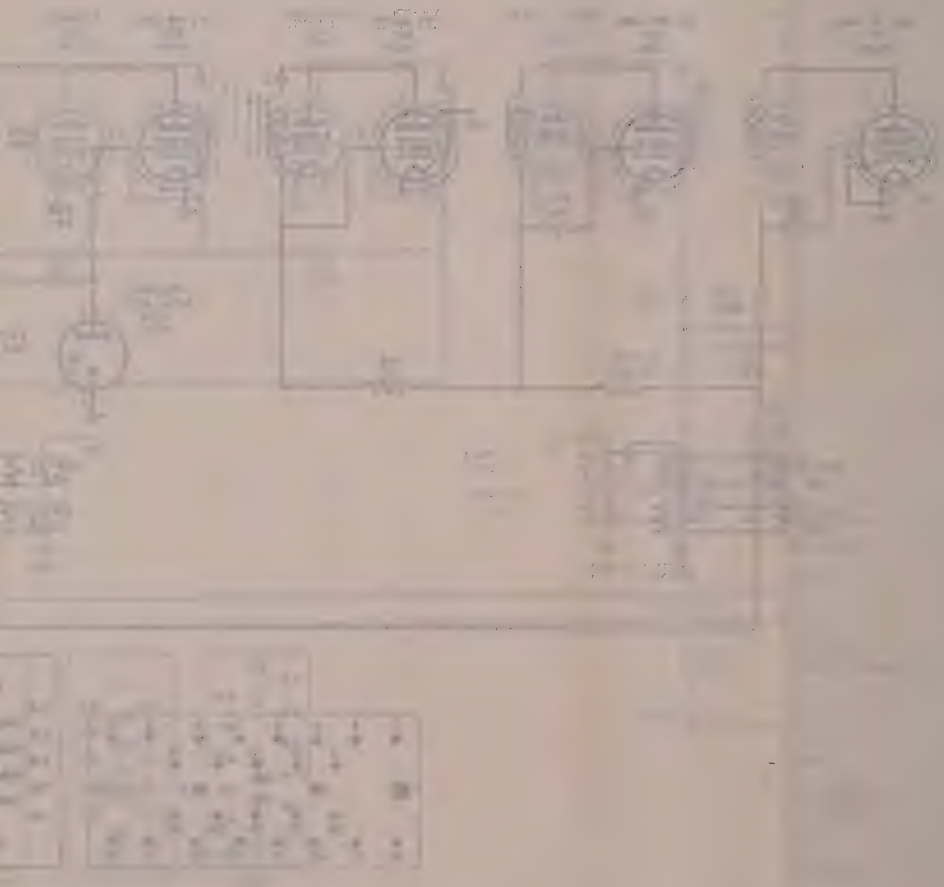
Figure 43. Radio Receiver R-394/U, B+ distribution diagram.

TM 5092-617

344215 O - 55 (Faces p. 56) No. 1




GRD FROM
POWER SUPPLY
14 V DC FROM
POWER SUPPLY
14
13
2



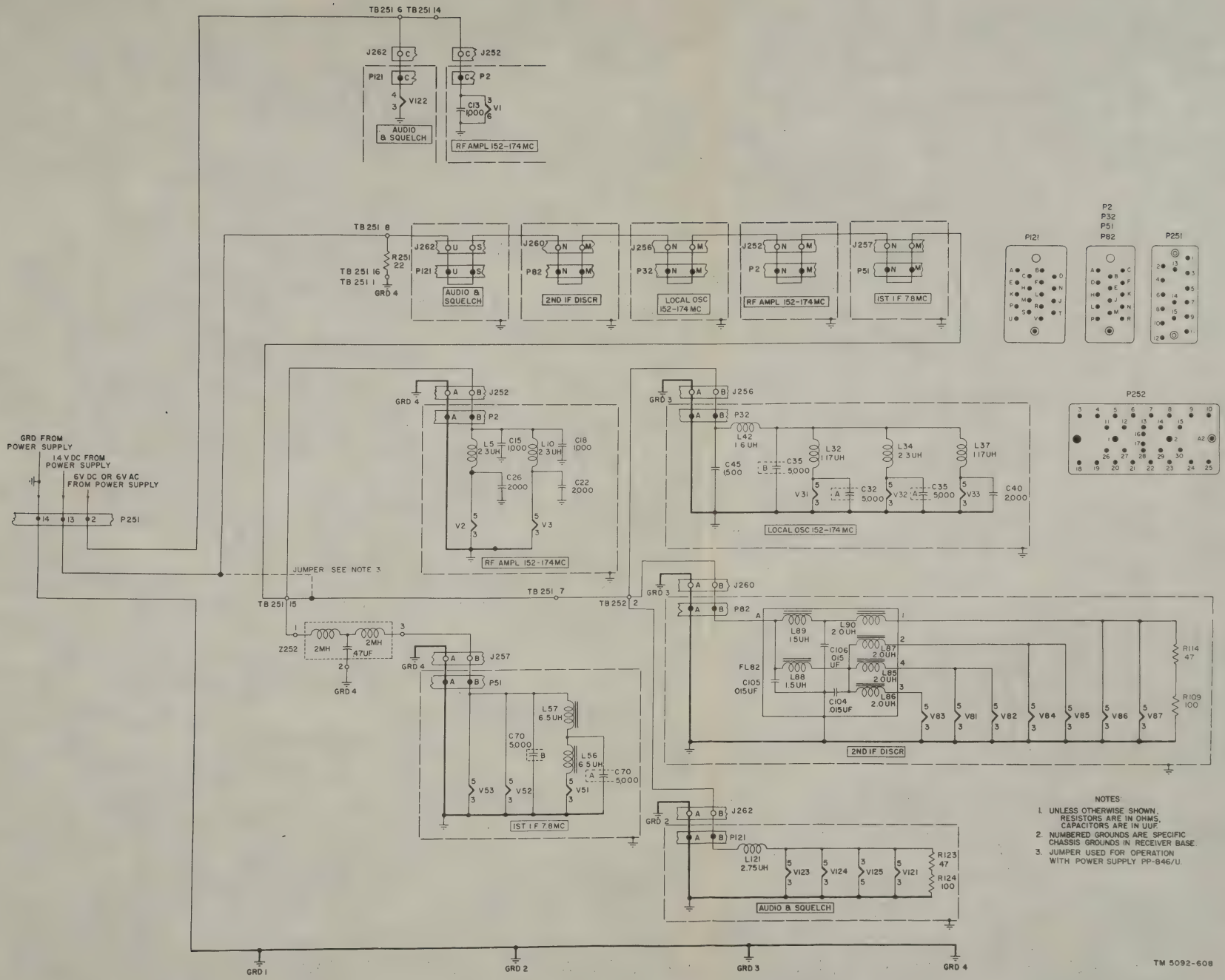
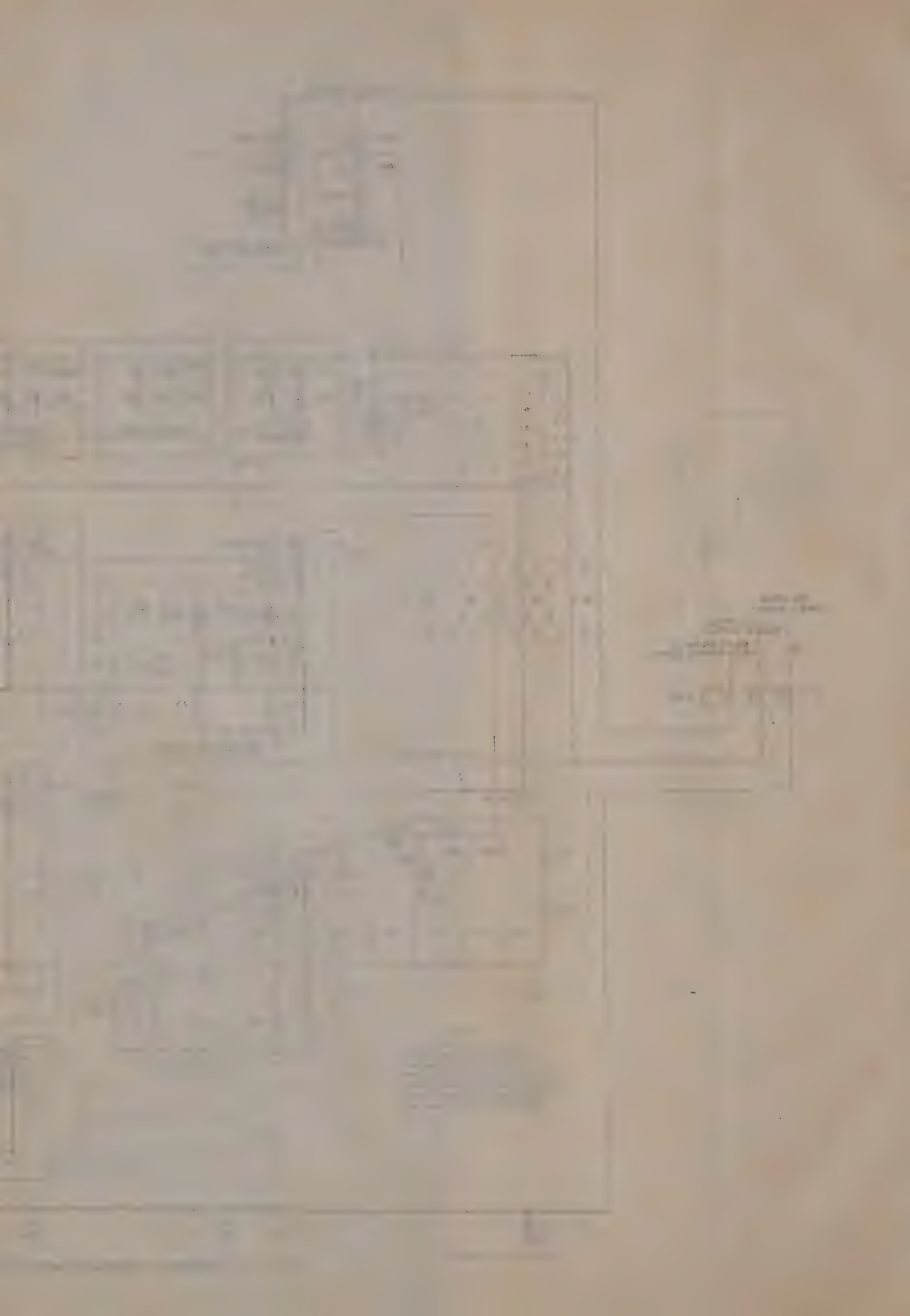


Figure 44. Radio Receiver R-394/U, filament distribution schematic diagram.

344215 O - 55 (Faces p. 56) No. 2



which overloads the power supply appreciably. the power supply fuse may or may not blow, depending upon the excessiveness of the B+ current. Removing one plug-in unit at a time in some cases will indicate which plug-in unit contains the B+ short. Removal of the defective unit will cause the B+ reading to increase to a value slightly higher than that produced by removal of nondefective unit.

c. Since a B+ short often will cause resistors or capacitors to overheat, inspect the receiver base and each plug-in unit for evidence of charred or discolored resistors or capacitors. Ceramic type capacitors, as used in this receiver, often will burn a white spot on their body that can be detected easily. If charred resistors are located, check their bypass capacitors with an ohmmeter. It is advisable to locate B+ shorts by resistance checks if parts in the receiver are overheating. If a leaky capacitor is causing the trouble, and none of the parts seem to be overheating, plate voltage and screen voltage measurements with a voltmeter or vacuum-tube voltmeter (vtvm) can localize the trouble to the defective part. Leaky coupling capacitors can be located by checking for a positive voltage on the control grids of the tubes. If this is the case, test the tubes involved, because a positive grid voltage may cause excessive plate current and damage the tube.

d. Replace charred or discolored resistors even if they are close to their required value. A resistor that has been overheated often will crack, change in value appreciably, or open.

70. Checking Filament Circuits

a. Radio Receiver R–394/U uses two filament voltages, 6.3 volts ac or dc, and 1.4 volts dc. Each plug-in unit (except the RELAY) contains an interlock jumper which opens the 1.4-volt filament circuit when the plug-in unit is removed. The normal filament voltage depends on all the tubes drawing their normal current. If it were not for this filament interlock feature, the filament voltage on the remaining tubes would rise whenever one of the plug-in units is removed from the receiver base. When Power Supply PP–846/U is used, a jumper connection is made between terminals 7 and 8 of TB251 (par. 68*a*). This jumper bypasses the interlocks in the plug-in units. (The interlock feature is not necessary when Power Supply PP–846/U is used because this power supply provides better voltage regulation than the battery-operated power supplies.)

b. Reference to figure 44 shows the filament distribution through the receiver. Ground connections marked GRD 1 through GRD 4 are specific ground points in the receiver base, and are indicated as such for the purpose of location and identification. This schematic diagram will aid in locating defects in the filament circuits.

c. Most of the filaments are bypassed to ground with ceramic capacitors. Defects in the filament circuits may be caused by shorts through these capacitors.

71. Checking B+ and Filament Circuit Defects in Receiver Base

a. The receiver base consists mainly of cables and connectors with the exception of a few resistors and capacitors. In the event that a defect in the B+ circuit or the filament circuit has been sectionalized to the receiver base, check the base as described below.

b. Remove the receiver from its case and also remove the power supply and all the plug-in units. The receiver base schematic diagram (fig. 36) and the overall receiver schematic (fig. 78) will be of assistance in troubleshooting. If the trouble is known to be in the filament circuits, use the filament circuits schematic diagram (fig. 44). If the trouble lies in the B+ circuits, use the B+ distribution diagram (fig. 43).

c. Resistance measurements between points in the receiver base will aid in detecting open circuits. Figure 57 shows voltages obtained in the receiver base when the receiver is operating. Resistance measurements are taken with the receiver disconnected from the radio set case.

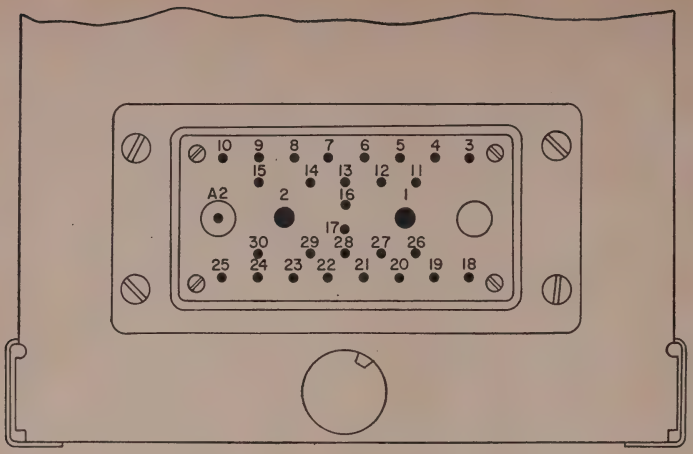
72. Operational Test

After completing the check and repair of any defects in the B+ and filament circuits, operate the receiver as described in paragraphs 17 through 21. If defects still exist, follow the procedures described in paragraphs 73 through 82.

73. Sectionalization Trouble to Plug-in Unit

a. In most cases the failure of Radio Receiver R–394/U will be caused by trouble in one of the

K4KKZ/AA
CHES WATKINS
P. O. BOX 3268



TERMINAL	RESISTANCE	TERMINAL	RESISTANCE	TERMINAL	RESISTANCE
1	0	11	∞	21	∞
2	∞	12	∞	22	∞
3	∞	13	∞	23	∞
4	∞	14	0	24	∞
5	∞	15	.6	25	∞
6	4	16	∞	26	∞
7	∞	17	1.8 MEG	27	∞
8	140K	18	∞	28	∞
9	1.2 MEG	19	∞	29	∞
10	∞	20	∞	30	∞
				A2	100K

NOTES.

1. RESISTANCE MEASUREMENTS MADE AT CONNECTOR P252 WITH POWER SUPPLY REMOVED FROM THE RECEIVER.
2. ALL RESISTANCE MEASUREMENTS MADE WITH A VTVM BETWEEN GROUND AND TERMINALS SPECIFIED.

TM 5092-601

Figure 45. Radio Receiver R–394/U, resistance measurements on main connector P252.

plug-in units. The first step in troubleshooting the receiver consists of measuring the filament voltage and the B+ voltage at the test jacks (FIL and B+, respectively) on the front panel of the receiver. These tests indicate whether the proper power is being obtained by the receiver. The first rf amplifier, V1, and the audio power amplifier (pa), V122, are the only tubes using 6 volts as heater voltage. A test for this voltage can be made by removing the RF AMPL 152–174 MC plug-in unit and the AUDIO & SQUELCH plug-in unit and actually feeling these two tubes to determine whether they are warm, as they should be if the 6-volt heater voltage is present.

b. The next step consists of removing each plug-in unit and replacing it with a similar unit known to be in good operating condition. For this test to be complete, the RF AMPL 152–174 MC plug-in unit and the LOCAL OSC 152–174

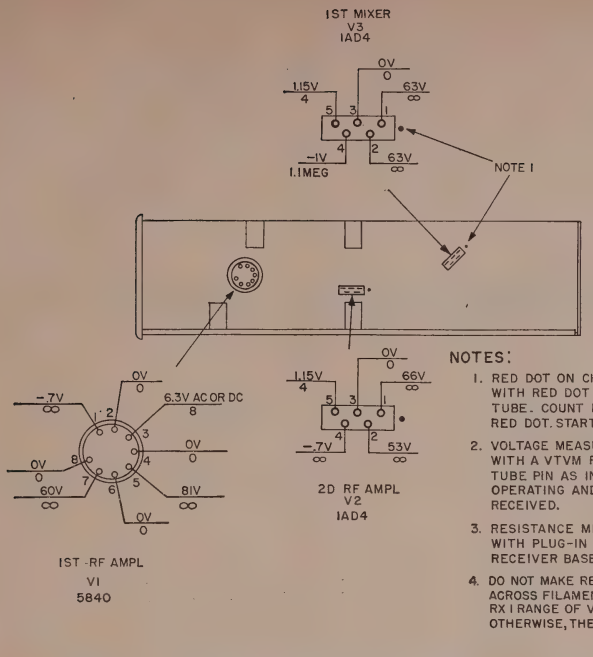


Figure 46. Radio Receiver R-394/U, RF AMPL 152-174 MC plug-in unit, tube socket voltage and resistance measurements.

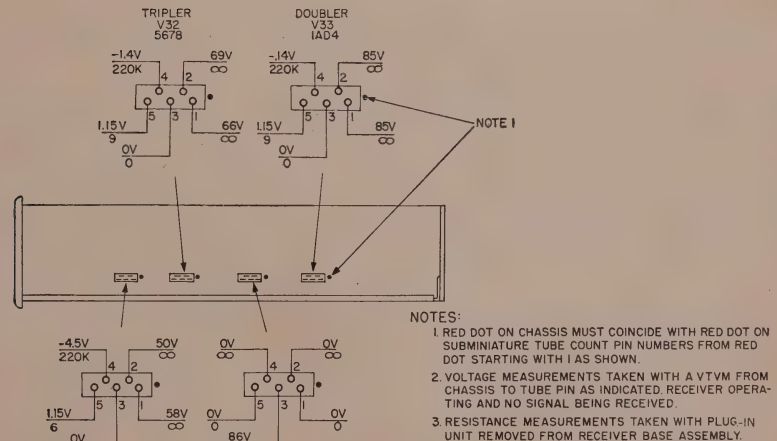


Figure 47. Radio Receiver R-394/U, LOCAL OSC 152-174 MC plug-in unit, tube socket voltage and resistance measurements.

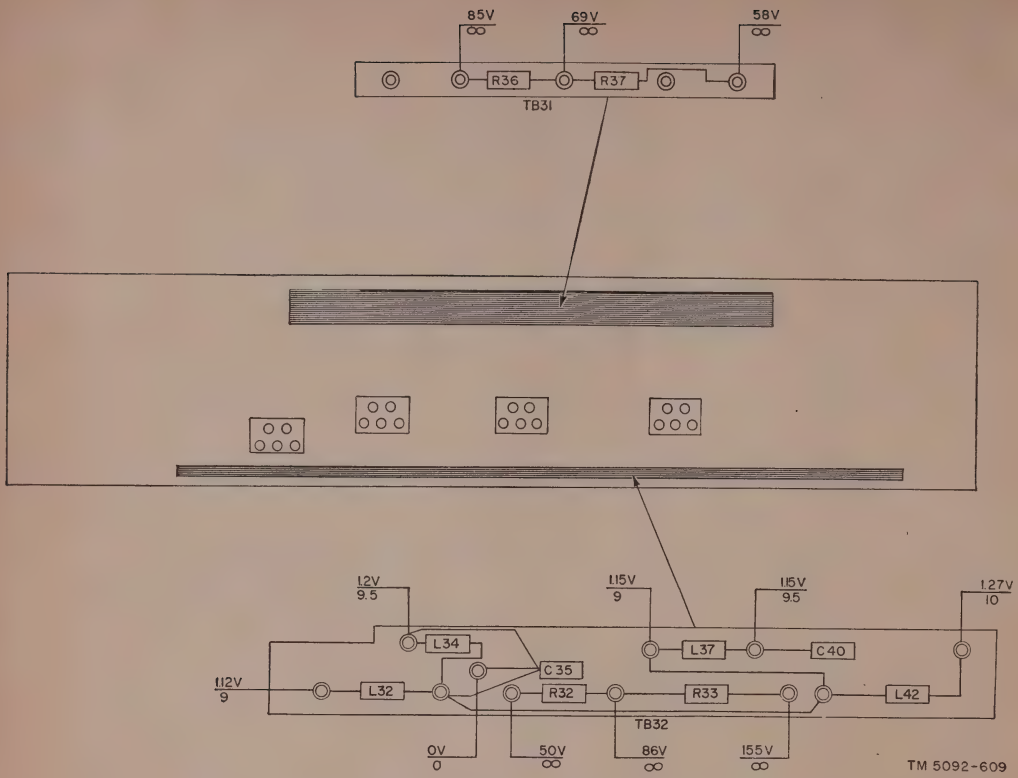


Figure 48. Radio Receiver R–394/U, LOCAL OSC 152–174 MC plug-in unit, terminal board voltage and resistance measurements.

MC plug-in unit being used for the substitution test must be alined previously to the same frequencies as the two similar units under test.

c. After the defective plug-in unit has been isolated it can be checked while installed in the receiver base. Use the troubleshooting chart (par. 74).

74. Troubleshooting Chart

The following chart is supplied as an aid in locating trouble in the receiver. It lists the symptoms which the repairman observes, either visually or audibly, while making a few simple tests. The signal substitution test outlined in paragraph 76 can be used to supplement this procedure and to determine the defective stage. After the trouble has been localized to a stage or circuit, a tube check and voltage and resistance measurements of this stage or circuit should be sufficient to isolate the defective parts. Normal voltage and resistance measurements are given in figures 45 through 57.

Symptom	Probable trouble	Correction
1. VOLUME control in control unit turned clockwise to turn power on. POWER pilot lamp in control unit fails to light.	1. Receiver main connector P252 not making good contact.	1. Remove receiver from case and inspect P252 and its mating connector. Replace receiver carefully and test for power at test points B+ and FIL.

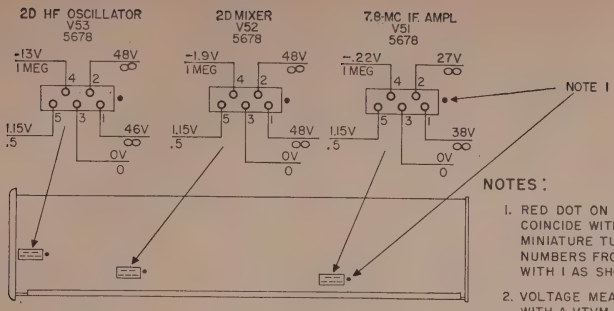

2D HF OSCILLATOR
V53
5678
2D MIXER
V52
5678
7.8-MC IF. AMPL
V51
5678
NOTE 1
NOTES:
1. RED DOT ON CHASSIS MUST COINCIDE WITH RED DOT ON SUB-MINIATURE TUBE. COUNT PIN NUMBERS FROM RED DOT STARTING WITH 1 AS SHOWN.
2. VOLTAGE MEASUREMENTS TAKEN WITH A VTVM FROM CHASSIS TO TUBE PIN AS INDICATED. RECEIVER OPERATING AND NO SIGNAL BEING RECEIVED
3. RESISTANCE MEASUREMENTS TAKEN WITH PLUG-IN UNIT REMOVED FROM RECEIVER BASE ASSEMBLY
4. DO NOT MAKE RESISTANCE MEASUREMENT ACROSS FILAMENT OF 1.4-VOLT TUBE ON R X 1 RANGE OF VTVM USE R X 10 RANGE OTHERWISE, THE FILAMENT MAY BURN OUT.
TM 5092-603

Figure 49. Radio Receiver R-391/U, 1ST IF 7.8 MC plug-in unit, tube socket voltage and resistance measurements.

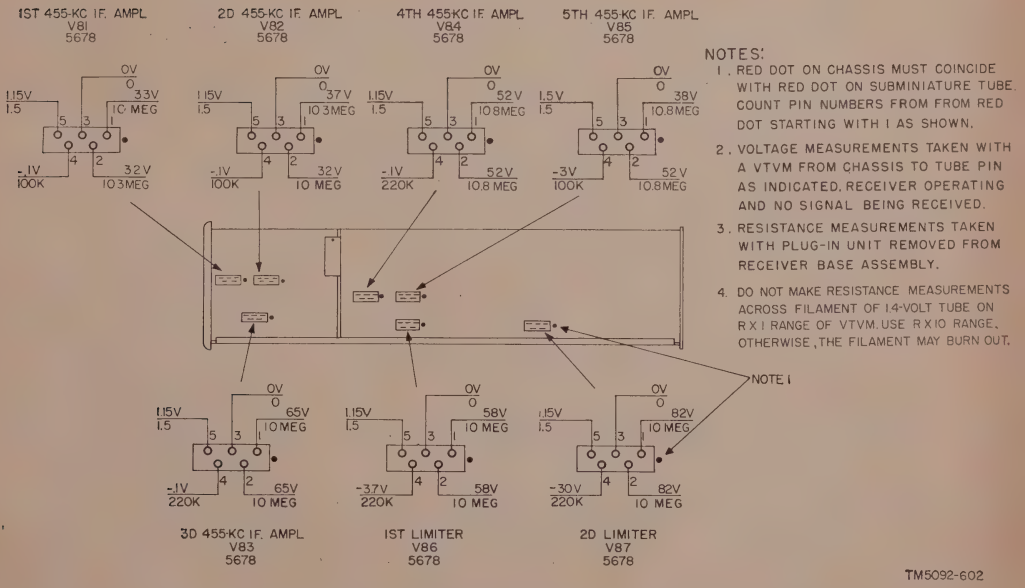

1ST 455-KC IF. AMPL
V81
5678
2D 455-KC IF. AMPL
V82
5678
4TH 455KC IF. AMPL
V84
5678
5TH 455-KC IF. AMPL
V85
5678
NOTES:
1. RED DOT ON CHASSIS MUST COINCIDE WITH RED DOT ON SUBMINIATURE TUBE. COUNT PIN NUMBERS FROM FROM RED DOT STARTING WITH 1 AS SHOWN.
2. VOLTAGE MEASUREMENTS TAKEN WITH A VTVM FROM CHASSIS TO TUBE PIN AS INDICATED. RECEIVER OPERATING AND NO SIGNAL BEING RECEIVED.
3. RESISTANCE MEASUREMENTS TAKEN WITH PLUG-IN UNIT REMOVED FROM RECEIVER BASE ASSEMBLY.
4. DO NOT MAKE RESISTANCE MEASUREMENTS ACROSS FILAMENT OF 1.4-VOLT TUBE ON R X 1 RANGE OF VTVM. USE R X 10 RANGE, OTHERWISE, THE FILAMENT MAY BURN OUT.
NOTE 1
3D 455-KC IF. AMPL
V83
5678
1ST LIMITER
V86
5678
2D LIMITER
V87
5678
TM5092-602

Figure 50. Radio Receiver R-391/U, 2ND IF DISCR plug-in unit, tube socket voltage and resistance measurements.

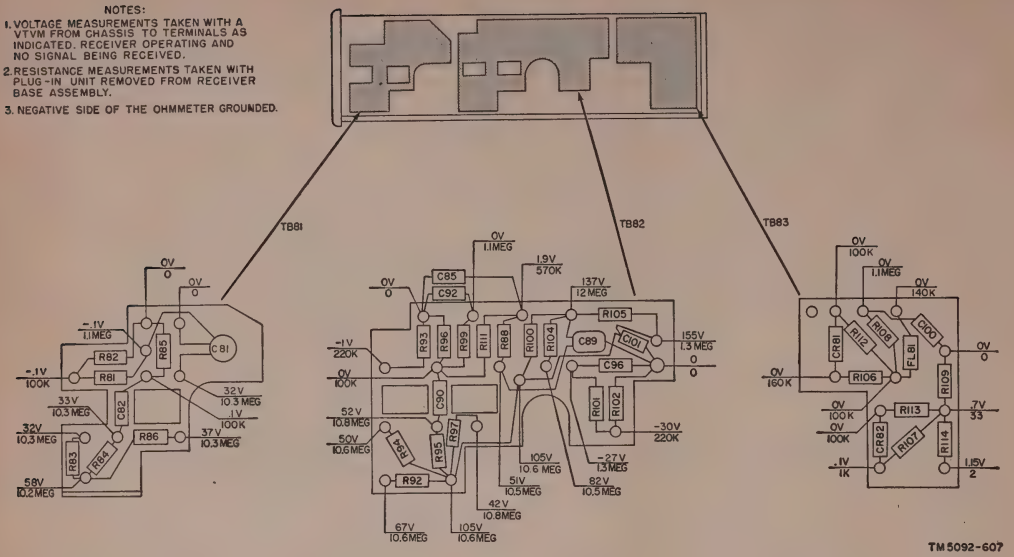

NOTES:
1. VOLTAGE MEASUREMENTS TAKEN WITH A VTVM FROM CHASSIS TO TERMINALS AS INDICATED. RECEIVER OPERATING AND NO SIGNAL BEING RECEIVED.
2. RESISTANCE MEASUREMENTS TAKEN WITH PLUG-IN UNIT REMOVED FROM RECEIVER BASE ASSEMBLY.
3. NEGATIVE SIDE OF THE OHMMETER GROUNDED.
TB81
TB82
TB83
TM 5092-607

Figure 51. Radio Receiver R-394/U, 2ND IF DISCR plug-in unit, terminal board voltage and resistance measurements.

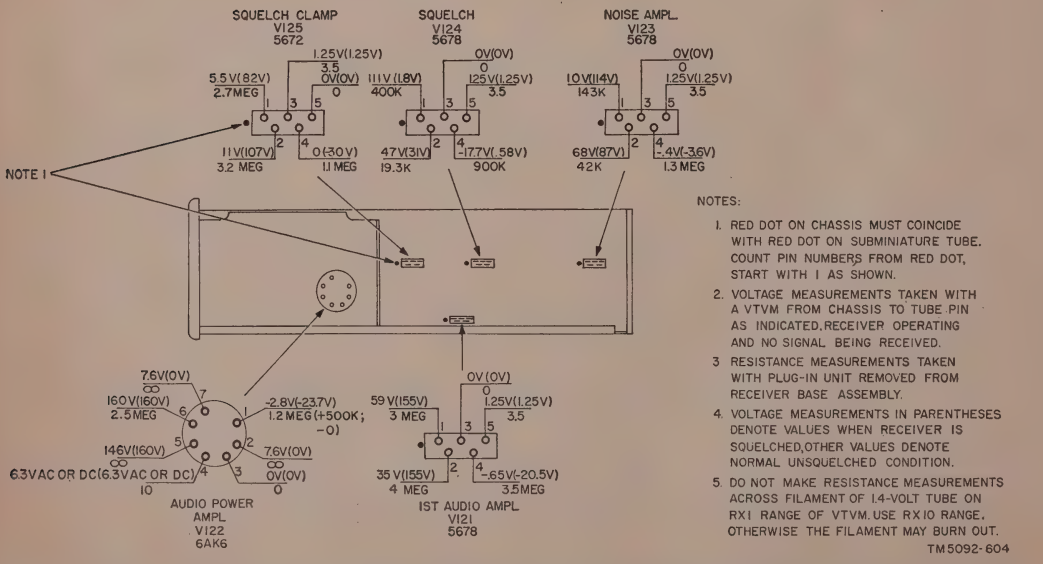

SQUELCH CLAMP V125 5672
SQUELCH V124 5678
NOISE AMPL. V123 5678
NOTE 1
AUDIO POWER AMPL. V122 6AK6
IST AUDIO AMPL. V121 5678
NOTES:
1. RED DOT ON CHASSIS MUST COINCIDE WITH RED DOT ON SUBMINIATURE TUBE. COUNT PIN NUMBERS FROM RED DOT, START WITH 1 AS SHOWN.
2. VOLTAGE MEASUREMENTS TAKEN WITH A VTVM FROM CHASSIS TO TUBE PIN AS INDICATED. RECEIVER OPERATING AND NO SIGNAL BEING RECEIVED.
3. RESISTANCE MEASUREMENTS TAKEN WITH PLUG-IN UNIT REMOVED FROM RECEIVER BASE ASSEMBLY.
4. VOLTAGE MEASUREMENTS IN PARENTHESES DENOTE VALUES WHEN RECEIVER IS SQUELCHED, OTHER VALUES DENOTE NORMAL UNSQUELCHED CONDITION.
5. DO NOT MAKE RESISTANCE MEASUREMENTS ACROSS FILAMENT OF 1.4-VOLT TUBE ON RX1 RANGE OF VTVM. USE RX10 RANGE, OTHERWISE THE FILAMENT MAY BURN OUT.
TM 5092-604

Figure 52. Radio Receiver R-394/U, AUDIO & SQUELCH plug-in unit, tube socket voltage and resistance measures (for plug-in units on Order No. 11661-Phila-52 with serial numbers 1 through 1213).

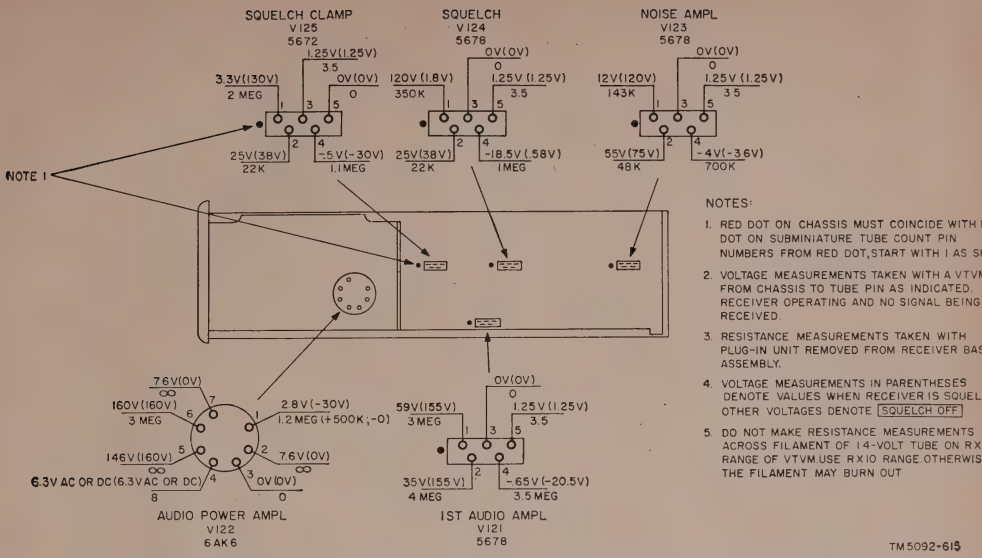

SQUELCH CLAMP
V125
5672
SQUELCH
V124
5678
NOISE AMPL
V123
5678
NOTE 1
NOTES:
1. RED DOT ON CHASSIS MUST COINCIDE WITH RED DOT ON SUBMINIATURE TUBE COUNT PIN NUMBERS FROM RED DOT, START WITH 1 AS SHOWN
2. VOLTAGE MEASUREMENTS TAKEN WITH A VTVM FROM CHASSIS TO TUBE PIN AS INDICATED. RECEIVER OPERATING AND NO SIGNAL BEING RECEIVED.
3. RESISTANCE MEASUREMENTS TAKEN WITH PLUG-IN UNIT REMOVED FROM RECEIVER BASE ASSEMBLY.
4. VOLTAGE MEASUREMENTS IN PARENTHESES DENOTE VALUES WHEN RECEIVER IS SQUELCHED. OTHER VOLTAGES DENOTE SQUELCH OFF
5. DO NOT MAKE RESISTANCE MEASUREMENTS ACROSS FILAMENT OF 14-VOLT TUBE ON RX1 RANGE OF VTVM. USE RX10 RANGE. OTHERWISE, THE FILAMENT MAY BURN OUT
AUDIO POWER AMPL
V122
6AK6
1ST AUDIO AMPL
V121
5678
TM 5092-615

Figure 53. Radio Receiver R–394/U, AUDIO & SQUELCH plug-in unit tube socket voltage and resistance measurements (for all plug-in units except those on Order No. 11661–Phila–52 with serial numbers from 1 through 1213).

Symptom	Probable trouble	Correction
2. No audio output even when SQUELCH control is turned fully cw to set the squelch disable switch in the OFF position.	2. Defective tubes V121 or V122.	2. Test and replace if necessary.
	T121 open.	Check with ohmmeter, replace if necessary.
	C126 or R121 open.	Test by bridging a new part across the original part. Replace if necessary.
	C125, C124 or C121 shorted.	Check with ohmmeter, replace if necessary.
3. Receiver output and noise very low or completely dead.	3. V81 through V87 defective.	3. Check tubes, replace defective one.
	Resistor or capacitor failure.	Check voltages and resistances. Also check resistances of coils for failure.
	V51 or V52 defective.	Check tubes V51 and V52, replace defective tube.
	Voltages and resistances not normal because of part failure. Check with vtvm.	Isolate and replace defective part.
4. Rushing noise received, but no signal from a transmitter known to be operating on the receiver frequency.	4. Trouble could be in the RF AMPL 152–174 MC plug-in unit, LOCAL OSC 152–174 MC plug-in unit, or the 1ST IF 7.8 MC plug-in unit.	4. Check these units by substitution of units known to be in proper operating condition and alined to the correct frequencies. Repair or aline the defective unit, as required.
	First hf oscillator V31, or the second hf oscillator V53 not oscillating.	Check the control grids of these tubes with a vtvm. The voltage should be negative with respect to ground. If the reading is not negative, check the tubes, voltages and crystals.

NOTES:

1. VOLTAGE MEASUREMENTS TAKEN WITH A VTVM FROM CHASSIS TO POINTS INDICATED. RECEIVER OPERATING AND NO SIGNAL BEING RECEIVED.
2. RESISTANCE MEASUREMENTS TAKEN WITH PLUG-IN UNIT REMOVED FROM RECEIVER BASE ASSEMBLY.
3. NEGATIVE SIDE OF METER GROUNDED FOR RESISTANCE MEASUREMENTS.
4. SQUELCH SET AT OFF.

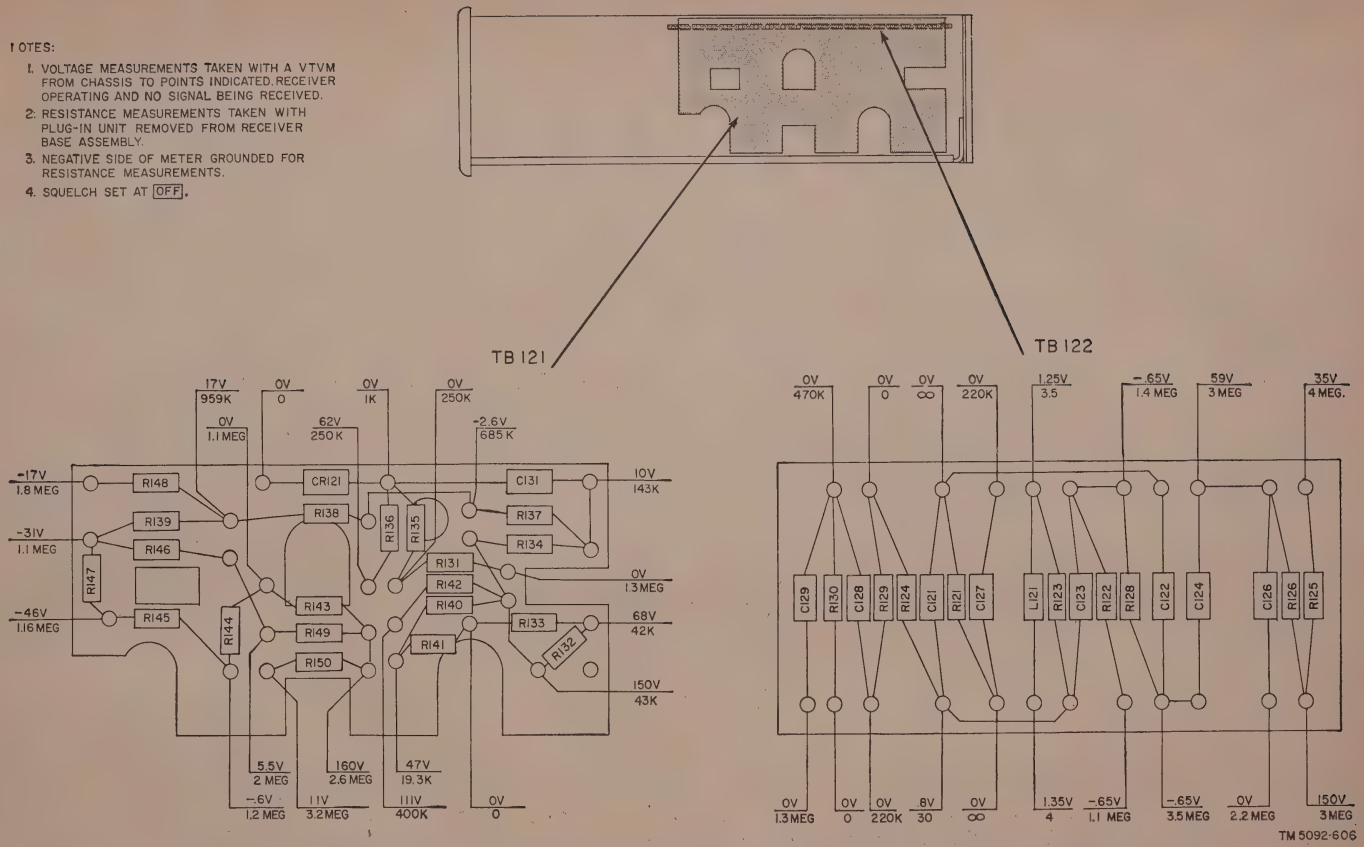


Figure 54. Radio Receiver R-394/U, AUDIO & SQUELCH plug-in unit, terminal board voltage and resistance measurements (for all plug-in units on Order No. 11661-Phila-52 with serial numbers 1 through 1213).

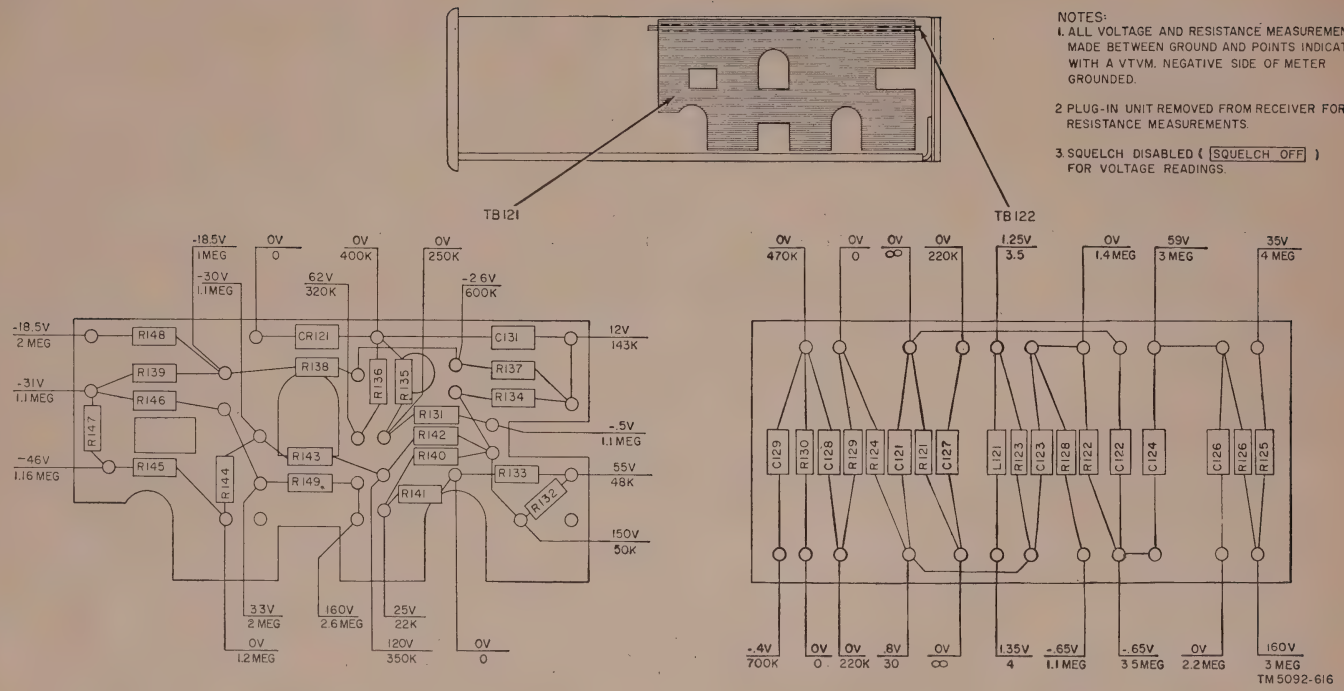


Figure 55. Radio Receiver R-394/U, AUDIO & SQUELCH plug-in unit, terminal board voltage and resistance measurements (for all plug-in units except those on Order No. 11661-Phila-52 with serial numbers 1 through 1213).

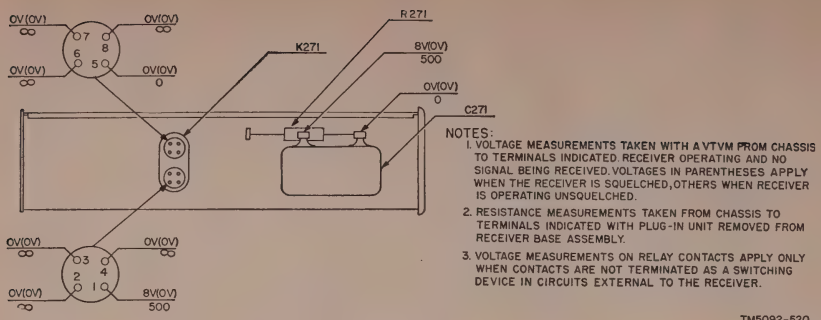


Figure 56. Radio Receiver R-394/U, RELAY plug-in unit, voltage and resistance measurements.

Symptom	Probable trouble	Correction
5. No receiver signal output, but receiver noise exists.	5. Failure of LOCAL OSC plug-in unit.	5. Follow instructions below.
	Defective tubes V31, V32, V33.	Replace.
	Crystal Y31 defective.	Replace.
	Resistor, capacitor or coil failure.	Check circuit with a vtvm, replace defective part.
	Second hf oscillator V53 not oscillating. Check pin 4 (grid) of V53 for a negative voltage.	Check V53, crystal Y51; also check voltages on plate and screen. Isolate and replace defective part.
	Tube V3 defective.	Replace.
6. Receiver output and noise lower than normal.	6. Leaky coupling capacitors C82, C84, C88, C90, C91 and C95.	6. Check with vtvm, replace defective capacitor.
7. Receiver noise is audible but sensitivity poor.	7. Tubes V1 or V2 defective.	7. Check and replace defective tube.
	Resistor, capacitor or coil defective.	Check parts with a vtvm, replace.
8. Audio output from receiver weak, distorted, or both.	8. Defect in audio amplifier stages of AUDIO & SQUELCH plug-in unit, or in discriminator circuit of the 2ND IF DISCR plug-in unit.	8. Replace both of these units, one at a time. If one of them is faulty, test the tubes, voltages, and resistances.
	C126, C124, C122, C121 or C123 leaky.	Unsolder one lead from each, test with ohmmeter, replace if necessary.
	CR81 or CR82 open.	Check front and back resistance with an ohmmeter, replace if necessary.
	T81 out of alinement.	Aline.
9. Receiver will not unsquelch unless SQUELCH control is in OFF position.	9. V123 defective.	9. Replace.
	Defective component in squelch circuit.	Check voltages and resistance.
10. Receiver will not squelch.	10. V124 defective.	10. Replace.
	Defective component in squelch circuit.	Check voltages and resistances.
11. Audio output distorted when squelch disable switch is open.	11. V125 defective.	11. Replace.
12. Receiver blocks on strong signals, operates normally on weak ones.	12. Capacitor C12 or C32 shorted or leaky.	12. Replace.

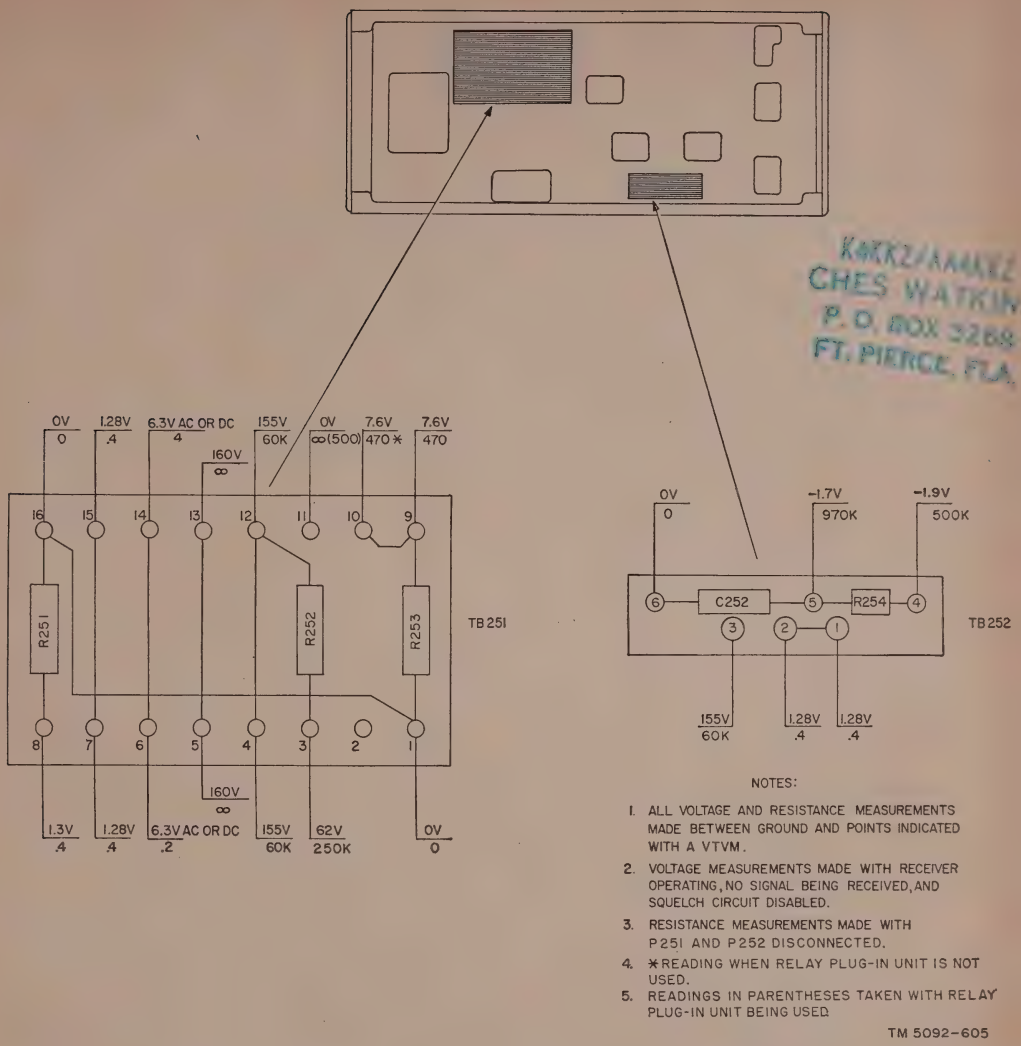


Figure 57. Radio Receiver R–394/U, voltage and resistance measurements of base.

Symptom	Probable trouble	Correction
13. Frequency of LOCAL OSC plug-in unit drifts.	13. Crystal oven E31 not functioning properly. Check heater winding and thermostat.	13. Replace defective part.
	VR31 defective, fails to glow.	Replace.
	Crystal Y31 defective.	Replace crystal and check for drift.

75. Additional Troubleshooting Information

a. Dc Resistance of Coils and Chokes in the RF AMPL 152–174 MC Plug-in Unit.

Choke or coil	Terminals	Resistance (ohms)
L1 (Z1)	1–2	Less than .1
L2	Wire leads	Less than .1
L3 (Z2)	1–3	Less than .1
L4 (Z3)	1–3	Less than .1
L5	Wire leads	.47
L6	Wire leads	.7
L7 (Z4)	1–3	Less than .1
L8 (Z5)	1–3	Less than .1
L9	Wire leads	.47
L10	Wire leads	Less than .1
L11	Wire leads	Less than .1
L12 (Z6)	1–2	.32
L13	Wire leads	.47

b. Dc Resistance of Coils and Chokes in the LOCAL OSC 152–174 MC Plug-in Unit.

Choke or coil	Terminals	Resistance (ohms)
HR31 heater	1–7	107.0
HR31 heater	3–7	5.7
L31 (Z31)	2–3	.60
L32	Wire leads	.32
L33	Wire leads	.72
L34	Wire leads	.47
L35	2–3	Less than .1
L36	2–3	Less than .1
L37	Wire leads	.32
L38	Wire leads	.70
L39	1–2	Less than .1
L39	2–3	Less than .1
L40	Wire leads	.70
L41	Wire leads	.70
L42	Wire leads	.80

c. Dc Resistance of Coils and Chokes in the 1ST IF 7.8 MC Plug-in Unit.

Choke or coil	Terminals	Resistance (ohms)
L51 (Z51)	2–3	.32
L52 (Z52)	2–3	.32
L53 (Z53)	2–3	.32
L54 (Z54)	2–3	.32
L55 (Z55)	1–3	45
L56	Wire leads	Less than .1
L57	Wire leads	Less than .1
L58	Wire leads	4.2

d. Dc Resistance of Chokes, Coils, And Transformers In 2ND IF DISCR Plug-in Unit.

Choke or coil	Terminals	Resistance (ohms)
L85 to L90 inclusive (coils in filament filter FL82, a potted unit).	A–1	.96 to 1.1
	A–2	.72 to .83
	A–3	.96 to 1.1
	A–4	.72 to .83
L81 (Z81)	1–3	30.0
L82 (Z82)	2–3	28.0
T81	1–2	25.0
T81	3–4	43.0

e. Dc Resistance of Transformers and Chokes in the AUDIO & SQUELCH Plug-in Unit.

Choke or coil	Terminals	Resistance (ohms)
T121	1–2	500.0
T121	3–4	.50
L121	Wire leads	.46

f. Dc Resistance of the Relay Coil in the RELAY Plug-in Unit.

Choke or coil	Terminals	Resistance (ohms)
K271	1–5	500.0

76. Directions for Signal Substitution

a. Signal substitution (pars. 77 through 82) requires a source of audio, if. and/or rf signals. Use the signal generator which produces the desired signal required in any specific test (see par. 66).

b. A vtvm and a tube tester also are needed to isolate the defective parts after the faulty stage has been indicated by signal substitution.

c. In the tests indicated in paragraphs 77 through 82, ground one side of the signal generator output to the receiver chassis, and connect the other side through a capacitor, as instructed in the specific test, to the points in the receiver under test.

d. Note the volume obtained, and listen for serious distortion or abnormal noise. When working back through the receiver from the audio output stage towards the input stages,

reduce the signal generator output as required to eliminate the possibility of forcing a signal through a defective circuit. If a similar receiver in good operating condition is available, compare the results obtained from the receiver being tested with the receiver known to be operating properly.

e. If a certain point in the receiver which requires signal injection be difficult to touch with the test probe or clip, select another point directly connected to the first point. Such a test may be at the junction of two resistors, two capacitors, or on a terminal board. The serviceman must use his own judgment when such a circumstance arises.

f. Use extreme care when probing in the receiver. Connections and parts are small and in very close proximity with other parts. Check the wiring and solder connections while testing by signal substitution. A poor solder connection or similar fault may be the trouble being investigated.

77. Af Tests

Note. Before attempting any of the tests, be sure the squelch disable switch in the control unit is in the OFF position. Set the VOLUME control in the control unit to the extreme clockwise position.

a. Terminal 5 of V122 (*Plate of Audio Power Amplifier*). Apply an audio signal through a series capacitor (approximately .05 μf) to terminal 5 of V122. If the output of the audio generator is sufficient, an audio tone should be heard in the loudspeaker. If no audio signal is heard, inspect the audio output connections from the loudspeaker back to the audio output transformer, T121. Check this transformer for an open winding.

b. Terminal 1 of V122 (*Grid of Audio Power Amplifier*). Apply the audio signal from the signal generator to terminal 1 of V122. Reduce the audio output from the af generator if the volume becomes excessive. There should be a noticeable increase in volume as compared with the previous test. If no volume increase is obtained, or no audio signal is heard, check tube V122. If the tube is satisfactory, check the plate and screen voltages of V122. If these tests reveal no fault, check the 470-ohm resistor, R253, on TB251 in the receiver base. If the receiver uses the 500-ohm winding of relay K271 as the cathode resistance, check this winding for an open circuit.

c. Terminal 1 of V121 (*Plate of First Audio Amplifier*). Apply the audio signal to pin 1 of V121. If no audio signal is heard, check capacitor C126. If the audio signal is greatly reduced as compared with that of the previous test, advance potentiometer R127 clockwise and note any increase in volume. (Mark setting of R127 before performing this step.) If the volume increase is erratic, check potentiometer R127.

d. Terminal 4 of V121 (*Grid of First Audio Amplifier*). Apply the audio signal to pin 4 of V121. The audio signal should be greatly increased as compared with that of the previous test. If the audio tone from the loudspeaker is excessive, reduce the output from the af generator. If no volume increase is apparent, or no audio output is obtained, check tube V121. If the tube is satisfactory, check the plate and screen voltages of V121 and cathode resistors R123 and R124.

e. Junction of C127 and R121 (*Audio Input to AUDIO & SQUELCH Plug-in Unit*). Inject the audio signal from the signal generator at the junction of C127 and R121 and listen for the audio tone in the loudspeaker. If there is no output, check C121, and C122, and R121. If this check reveals no fault, check R122 and C123. As a final check on the audio section unit, break the connection to terminal R on P121. If audio noise can be obtained by injecting the signal generator at the junction of C127 and R121 the trouble probably is in the connection between the AUDIO & SQUELCH plug-in unit and the 2ND IF DISCR plug-in unit, or in the 2ND IF DISCR plug-in unit.

f. Junction of Terminal R on P82 and If. Filter (*Audio Output in 2ND IF DISCR Plug-in Unit*). Apply the audio signal from the signal generator to the junction of terminal R on P82 and if. filter FL81 (in early models) or C112 (in later models). If an audio signal is heard in the loudspeaker, apply the audio signal to the input terminal on FL81 (not the grounded one) or to the ungrounded terminal of C111 (in later models). If at this point no audio is obtained, check the if. filter.

78. Squelch Test

a. Test Setup.

(1) Set the SQUELCH control almost to its extreme clockwise position, but do not

advance it so far that the squelch disable switch is switched to the OFF position.

(2) Connect the audio oscillator between ground and the junction of C127 and R121. Adjust the audio oscillator to deliver 12,000 cycles per second (cps). Connect an ac vtvm across the audio oscillator. Connect a dc vtvm between ground and terminal 1 of V122.

b. Squelch Circuit Test. Set the audio oscillator attenuator control for zero output. The reading on the dc vtvm should be about —.25 volt. Slowly advance the output attenuator control on the audio oscillator until the needle suddenly jumps up to approximately —25 volts. At this point take a reading on the ac vtvm. The reading should be between 2.5 and 4.0 volts root mean square (rms). Note the reading just obtained and slowly decrease the output from the audio oscillator. When the dc vtvm reading suddenly drops to approximately —.25 volt, again read the ac vtvm. This voltage should be .5 volt rms less than the 12,000-cps voltage required to squelch the audio tubes.

c. Troubleshooting the Squelch Circuit. Refer to paragraph 59 for squelch circuit theory. When the audio tubes are unsquelched, noise amplifier tube V123 and squelch clamp tube V125 are conducting heavily as evidenced by the large voltage drops across their respective plate resistors. When the audio tubes are squelched, the squelch tube V124 conducts heavily as evidenced by the low plate voltage. Reference to the voltage and resistance data in figures 52 and 54, or 53 and 55 will be of assistance in troubleshooting the squelch circuit. Possible sources of trouble other than tubes or the germanium diode CR121 are the numerous series-connected resistors in this circuit. An open resistor or one that has changed in value appreciably will be a definite source of trouble.

d. Alternate Squelch Test. Another method of checking the operation of the squelch circuits consists of measuring the plate voltage of noise amplifier V123, squelch tube V124, and squelch clamp V125 as the 12,000 cps test signal is turned on and off. The voltages should agree approximately with the voltages given in figures 52 and 54, or 53 and 55.

79. If. Tests

a. 2ND IF DISCR Plug-in Unit.

(1) *Control settings.* Set the SQUELCH control in the OFF position. Set the VOLUME control in the fully clockwise position.

(2) *Terminal 1 of V87 (second limiter plate).* Apply a 455-kc, fm ±15-kc signal to ground and terminal 1 of V87 through a small mica capacitor of approximately 500 $\mu\mu$f. Use 1,000 cps as the modulating frequency. Advance the output of the signal generator until the 1,000-cps tone is heard in the loudspeaker. If no signal is heard in the speaker, check the discriminator transformer T81 primary and secondary windings for an open winding. Also check the germanium diodes CR81 and CR82.

(3) *Terminal 4 of V87 (second limiter control grid).* Inject the fm signal at pin 4 of V87. Reduce the output of the signal generator if necessary. If this test fails to produce any audio output or results in decreased audio output, check second limiter V87. If the tube is satisfactory, return it to its socket and measure the plate and screen voltages.

(4) *Terminal 1 of V86 (first limiter plate).* Apply the test signal to pin 1 of V86. The 1,000-cps tone should be approximately the same volume as in the preceding test. If there is a decrease in volume, or no output at all, check coupling capacitor C95 by bridging a similar capacitor across it.

(5) *Terminal 4 of V86 (first limiter control grid).* Apply the 1,000-cps fm test signal to pin 4 of V86. If the test fails, check the tube, and the plate and screen grid voltages. If the plate voltage is zero, or very low, check coil assembly Z82 for possible failure.

(6) *Terminal 1 of V85 (fifth 455-kc if. amplifier plate).* Apply the test signal to pin 1 of V85 and compare the audio output obtained from the previous test. They should be approximately the same. If the output is reduced or

absent, check coupling capacitor C91 for an open by bridging a similar capacitor across it.

(7) *Terminal 4 of V85 (fifth 455-kc if. amplifier control grid).* Inject the test signal at pin 4 of V85. The audio signal heard in the loudspeaker should increase in volume. If no increase is obtained, check the tube. If the tube is satisfactory, check tube voltages while noting any irregularity in the results obtained.

(8) *Terminal 1 of V84 back to and including terminal 4 of V81.* Continue testing tube socket voltages in the manner described above. The audio output should increase each time the test signal is transferred from the plate to the grid of any tube in the 455-kc if. amplifier. Note the following:

(*a*) The absence of plate and/or screen grid voltages can be caused by open resistors or shorted bypass capacitors.

(*b*) Positive control grids indicate leaky or shorted coupling capacitors, or a gassy tube.

(*c*) If plate or screen grid voltages are absent or low, refer to the Receiver R–394/U schematic diagram (fig. 78), and the B+ distribution diagram (fig. 43).

(*d*) Sometimes tubes develop short circuits and upset the plate and screen grid voltage readings. Be sure this is not the case before troubleshooting for defective capacitors or resistors.

b. 1ST IF 7.8 MC Plug-in Unit.

(1) *Terminal 1 of V52 (second mixer plate).* Apply the 455-kc fm test signal to pin 1 of tube V52. The audio output heard in the speaker should be of approximately the same volume as that obtained when applying the same signal to pin 4 of tube V81 in the 2ND IF DISCR plug-in unit. If this test fails, the fault possibly will be in coil assembly Z55 or in the coaxial connections between the plug-in units.

(2) *Terminal 4 of V52 (second mixer control grid).* Apply a 7.8-mc signal, frequency-modulated ±15 kc with a 1,000-cps audio voltage to pin 4 of V52 through a small mica capacitor. If this test fails, check V52, and the plate and screen voltages of this tube. If these checks produce no evidence of trouble, test second hf oscillator V53. If the tube is satisfactory, check the plate, screen and control grid voltages. A negative reading on the control grid indicates that the tube is oscillating. Do not discount the possibility of crystal Y51 being defective. (Y51 is a type CR–18/U.) If necessary, replace the crystal with one known to be good. Then check for a negative voltage on the control grid of V53.

(3) *Terminal 1 of V51 (7.8-mc if. plate).* Inject the 7.8-mc signal to pin 1 of V51. If the test fails, check coupling capacitors C58, C60, and C62 by injecting the 7.8-mc signal on their tie points while working towards second mixer V52.

(4) *Terminal 4 of V51 (7.8-mc if. control grid).* Apply the test signal to pin 4 of V51. A marked increase in volume should be noticed. If the test fails, check V51. Check the plate and screen grid voltages if the tube is satisfactory.

80. Rf Tests

a. Terminal 4 of V3 (Grid of first Mixer). Tune the signal generator to the receiver frequency and inject a strong signal frequency modulated ±15 kc with 1,000 cps at terminal 4 of V3 through a small mica capacitor (100 μμf). If no audio is heard in the speaker, increase the output of the signal generator and vary the signal generator frequency above and below its initial setting. If no audio is obtained, or the signal is weak, check V3. If the tube is satisfactory, check its plate and screen voltages.

b. Terminal 1 of V2 (Plate of Second Rf Amplifier). If the signal injection test in *a* above indicates that the trouble is ahead of first mixer V3, tune the signal generator to the receiver frequency and inject a signal on ter-

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minal 1 of V2. If this test suggests a failure, check coupling capacitor C21 and coil assemblies Z4 and Z5. Also check capacitors C30 and C31 for possible short circuits.

c. Terminal 4 of V2 (Grid of Second Rf Amplifier). Apply the rf signal to terminal 4 of V2. An increase in receiver output should be noticeable. If this is not the case, test V2. Return the tube to its socket if it is satisfactory and check tube voltages and resistances.

d. Terminal 5 of V1 (Plate of First Rf Amplifier). Inject the rf signal into terminal 5 of V1. The response should be comparable with that of the preceding test. If not, check coupling capacitor C20, coil assemblies Z2 and Z3, and capacitors C28 and C29.

e. Terminal 1 of V1 (Grid of First Rf Amplifier). Apply the rf signal to terminal 1 of V1. An increase in receiver output should be noticeable. If a failure is apparent in this stage, check the tube voltages and resistances. Proceed to the antenna input connector P1 and apply the signal at this point. If the receiver gain drops off, trouble may be located in coil assembly Z1 or in connector P1.

81. Agc Test

a. Radio Receiver R–394/U uses an agc circuit which applies a negative bias to the control grids of rf amplifiers V1 and V2. This bias is proportional to the signal strength of the received signal. The fifth 455-kc if. amplifier develops this bias at its control grid. A portion of this bias is fed back to the rf amplifiers through a resistance-capacitance (RC) network which is designed to filter out ac pick-up such as that resulting from ignition noise or similar types of interference.

b. Connect the signal generator to antenna input connector P1 and a dc vtvm to the test points marked 2ND IF. and GND on the front of the receiver. With the signal generator tuned to the receiver frequency and set at zero output, note the reading on the vtvm. Increase the output of the signal generator to maximum. The agc bias should increase also. Check this bias with a vtvm at the low end of the grid return resistors (R2 and R4) of V1 and V2 respectively. In the event that this bias is not apparent at the tubes, one of the components in the agc network, capacitors C12, C32, C252, or C85, or resistors R254 or R88 may be defective. Absence of agc voltage causes serious receiver overloading.

82. Stage Gain Charts

a. General. Stage gain measurements allow a check on the gain of individual stages in the receiver. When troubleshooting, the measurements serve to locate the defective stage which may be operative but low in signal output. The test signals injected into particular parts of the circuit are adjusted to develop a predetermined output signal either in the form of an audio output signal or the bias voltage developed across the grid resistor of the fifth 445-kc if. amplifier. As the source of test signal is moved from the output circuits toward the antenna input circuit of the receiver, less test signal voltage should be required to develop the required output. The receiver has no controls except the screwdriver-adjusted audio volume control (R127) in the AUDIO & SQUELCH plug-in unit.

b. Test Conditions.

(1) Use a 115- or 230-volt ac power supply (Power Supply PP–846/U). Adjust the line voltage to 115 or 230 volts.

(2) Allow the receiver and test equipment to warm up for at least 10 minutes.

(3) Turn the audio gain control (R127) in the AUDIO & SQUELCH plug-in unit fully clockwise (maximum gain).

(4) Turn the SQUELCH control in the control unit to the OFF position.

(5) The stage gain of individual stages should fall within the limits specified below. The limits are broad enough to accommodate variations in the quality of replacement tubes. However, the overall sensitivity of the receiver should be better than .5 microvolt (uv), as pointed out in the final test section.

c. Audio Stage Gain Chart. Connect an 8-ohm load across the secondary (terminals 3 and 4) of audio output transformer T121. The VOLUME control circuit and loud speaker in Electrical Equipment Cabinet CY–1150/U will apply the 8-ohm load if this cabinet is used.

Also connect an output meter across terminals 3 and 4. If the output meter supplies the 8-ohm audio load, no additional speaker circuit or resistor loading should be used. Connect a high impedance ac vtvm across the output terminals of the audio oscillator. Feed the 1,000-cps audio test signal to the points indicated. Use resistor R253 (470 ohms) as the cathode bias resistor of tube V122. If the squelch relay K271 is wired in as the cathode bias resistance, move the jumper on TB251 from terminals 10 and 11 to terminals 9 and 10.

Note. Audio output power will be higher if the squelch relay K271 is used as the cathode bias resistance, because K271 is bypassed with capacitor C271. Resistor R253 is not bypassed; therefore some degeneration occurs, and results in reduced gain of tube V122.

Input connection	Input voltage (volts)		Power at T121 secondary (watt)
	min	max	
Pin 1 of V122	6.1	13.6	.5
Pin 4 of V121	.073	.165	.5
Terminal R of P121	2.0	4.4	.5
Junction of R112 and FL81	2.4	5.4	.5

d. 455-Kc If. Stage Gain Chart.

(1) Connect a dc vtvm to the receiver test points marked GND and DISCR. Connect the if. signal generator to pin 4 of V84 through a 1,000 $\mu\mu$f mica capacitor. The dc vtvm should read +1 volt when the signal generator is tuned to 455 kc (unmodulated), indicating correct alinement of the discriminator. As the signal generator is varied above and below 455 kc, the needle on the vtvm should swing positive and negative. Use a test signal which develops a negative 3 volts at the test point 2ND IF. Vary the if. signal frequency above and below 455 kc. The discriminator output voltage (measured at the DISCR test point) should vary in different units from $\pm$20 to $\pm$30 volts. A larger test signal should not change these limits because of the limiting action of V86 and V87. Stage gain tests on these two stages indicate limiting action by increased grid-leak bias developed at the grids of V86 and V87 as the input test signal is increased. A test point at the grid of V87 is decoupled at the junction of R101 and C96.

(2) Connect the dc vtvm to the receiver test points marked GND and 2ND IF. Output voltage is measured at the control grid of V85 through the decoupling filter consisting of R99 and C92. Adjust the output of the unmodulated 455-kc if. test signal to obtain a —3-volt reading on the vtvm. Test the gain of the 455-kc if. stages as follows:

Input connection	Input voltage (uv)		Output at 2ND IF.
	min	max	
Pin 4 of V84	27,000	61,500	—3 volts
Pin 4 of V83	7,500	16,900	—3 volts
Pin 4 of V82	830	1,870	—3 volts
Pin 4 of V81	93	210	—3 volts
Pin 4 of V52	24	54	—3 volts

e. 7.8-mc If. Stage Gain Chart. Use the same vtvm connection used for the 455-kc if. tests. Feed an unmodulated 7.8-mc if. test signal to the circuits indicated through a 1,000-$\mu\mu$f mica capacitor.

Input connection	Input voltage (uv)		Output at 2ND IF.
	min	max	
Pin 4 of V51	32	72	—3 volts
Pin 4 of V3	11	25	—3 volts

f. Rf Stage Gain Chart. Apply an rf test signal of 152 to 174 mc as listed in the chart below through a 100-$\mu\mu$f mica capacitor. Be careful not to disturb any of the wiring in the RF AMPL 152–174 MC plug-in unit. The accuracy of the test at pin 4 of V2 depends on the amount of detuning and circuit loading resulting from the test connection at this point. Keep the mica capacitor as close to pin 4 of V2 as possible. The output impedance of the signal generator must not exceed 50 ohms.

Input connection	Input voltage (uv)		Output at 2ND IF.
	min	max	
Pin 4 of V2	8	18	—3 volts

Input connection	Input voltage (uv)		Output at 2ND IF.
	min	max	
Terminal 3 of Z1	.33	.75	—3 volts

Section II. REPAIRS

83. Special Tools Required for Replacement of Subminiature Parts

a. No special tools are shipped with Radio Receiver R–394/U. The smallest general purpose radio tools available are most suited for the repair of this receiver. Such tools as needle-nosed pliers and small diagonal cutters are more useful than the ordinary radio long-nosed pliers and cutters.

b. The tips on the test probes used for testing and alining this receiver should be kept clean. If possible, a point should be filed on the end of each probe tip in order to contact the parts being tested without exerting a force which could result in a broken part or wire.

84. Replacement of Parts

a. General. Refer to figures 58 through 70 for locations of the parts in the assemblies of Radio Receiver R–394/U.

b. Subminiature Tubes. Be careful when removing the subminiature tubes. Lift them straight up and away from the sockets. When replacing the subminiature tubes be sure that the red dot on the tube lines up with the red dot on the chassis. New subminiature tubes have long wire leads which must be cut to the proper length. Use the tube being replaced as a guide for the proper length of the wire leads. Pin numbers on the tubes begin with No. 1 at the red dot and progress to No. 5. When replacing V3, refer to paragraph 43*c*.

c. Coaxial Connectors of Plug-in Units. Loosen and remove four flat head screws on the bottom plate of the plug-in unit. This releases the bottom plate. Unsolder the leads attached to the coaxial connector and remove the connector.

d. Rf Bypass Capacitors with Solder Lugs. There are eight rf bypass capacitors on the RF AMPL 152–174 MC plug-in unit which are sol-

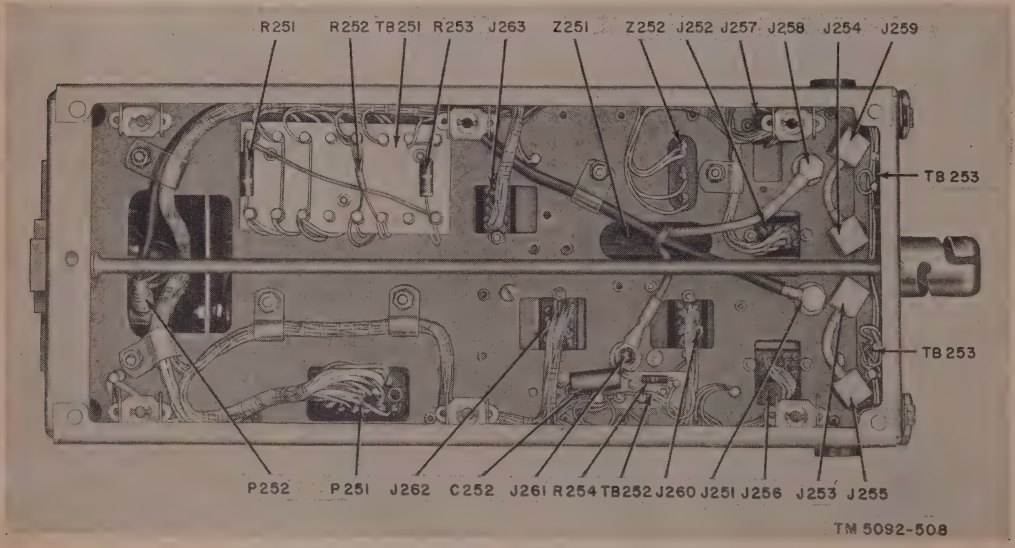

Figure 58. Radio Receiver R–394/U, base, bottom view.

dered to the chassis. When removing one of these capacitors, first unsolder the wire lead connected to it; then unsolder the connection at the chassis lug. When performing this operation, be careful that other parts are not burned by the soldering iron. Replace the new bypass capacitor by first soldering it to the chassis and then connecting the wire that was removed from the original capacitor.

e. Rf and If. Coils and Shield Cans. If the replacement of one of the rf or if. coil shield cans becomes necessary, proceed as follows:

(1) Unsolder all wires, capacitors, and resistors connected to the coil assembly.
(2) Remove the coil from the coil shield by removing the screws that retain it. Replace the coil with a new one if it is damaged.
(3) Remove all tubes in the vicinity of the coil shield to be replaced.
(4) Remove the original defective coil shield by cutting it away at its base. Use diagonal cutters or any tools capable of this function. Be sure no sharp edges remain. Use a small file to remove burrs.
(5) The replacement coil shield will be mounted with two spade-type lugs or studs. Measure, mark, and drill two holes on the plug-in unit for mounting this replacement coil shield. Be careful when drilling so that no other parts are damaged. Remove any metal chips caused by drilling or filing.
(6) Install the new coil shield and secure with nuts and lockwashers.
(7) Insert the coil, and note the correct positioning so that wires previously removed will fit.
(8) Reconnect wires, capacitors, and resistors.
(9) Check alinement of this plug-in unit.

85. Disassembly of Terminal Boards from Plug-in Units

When replacing a terminal board, observe the following precautions:

a. Unsolder the wires, capacitors, resistors and coils that connect to terminals on the terminal board from points not on the terminal board. Make sure that other terminals, especially on the subminiature tube sockets, are not broken or damaged. Tag each lead wire or group of wires so that they will be properly wired when the new terminal board is installed.

b. If the terminal board being replaced is one that contains numerous terminals, draw a pencil sketch of the board, and number each terminal with a number that agrees with the number on the corresponding tagged wire lead.

c. If it is necessary to replace a part on one of the terminal boards and the part is difficult to remove because of its location in the plug-in unit, remove the attaching parts of the terminal board and move it slightly to make the part to be replaced more accessible.

86. Refinishing

Instructions for refinishing are given in TM 9–2851, Painting Instructions for Field Use. Refinish outer surfaces when necessary.

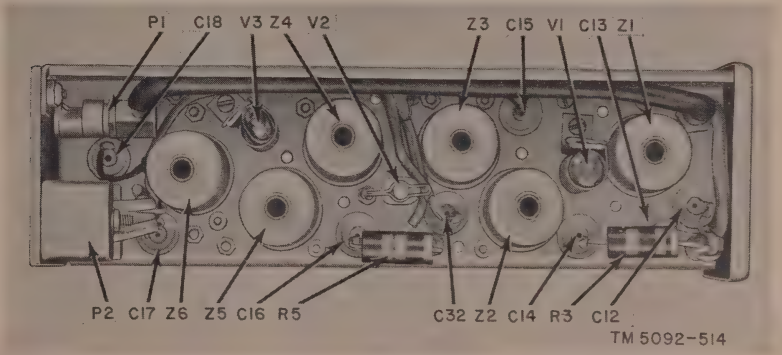

Figure 59. Radio Receiver R–394/U, RF AMPL 152–174 NC plug-in unit, top chassis view.

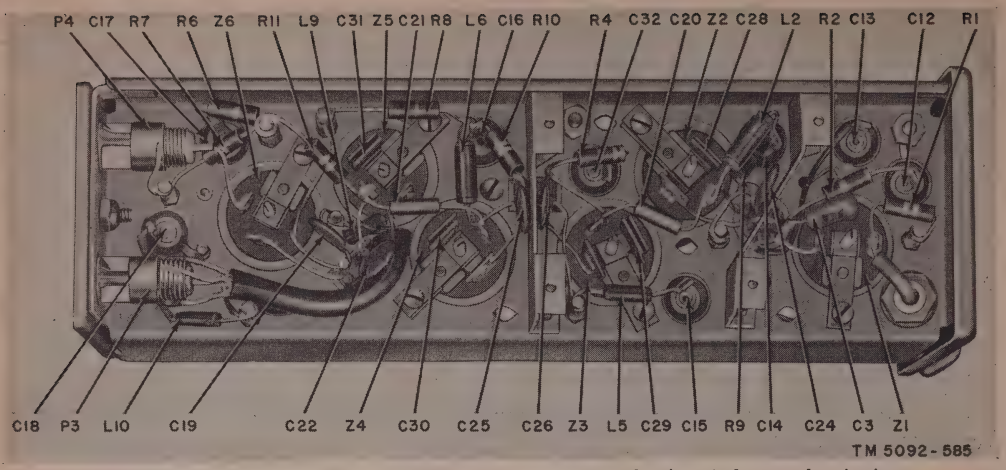

Figure 60. Radio Receiver R–394/U, RF AMPL 152–174 MC plug-in unit, bottom chassis view.

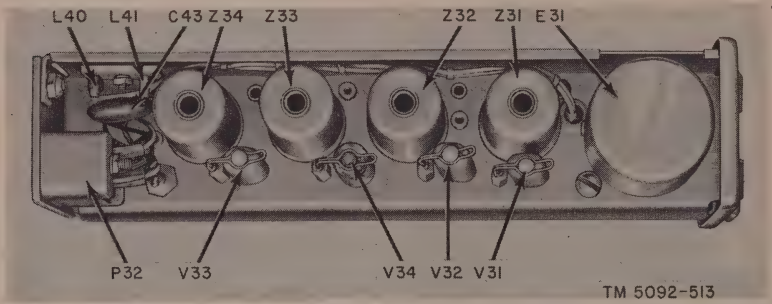

Figure 61. Radio Receiver R–394/U, LOCAL OSC 152–174 MC plug-in unit, top chassis view.

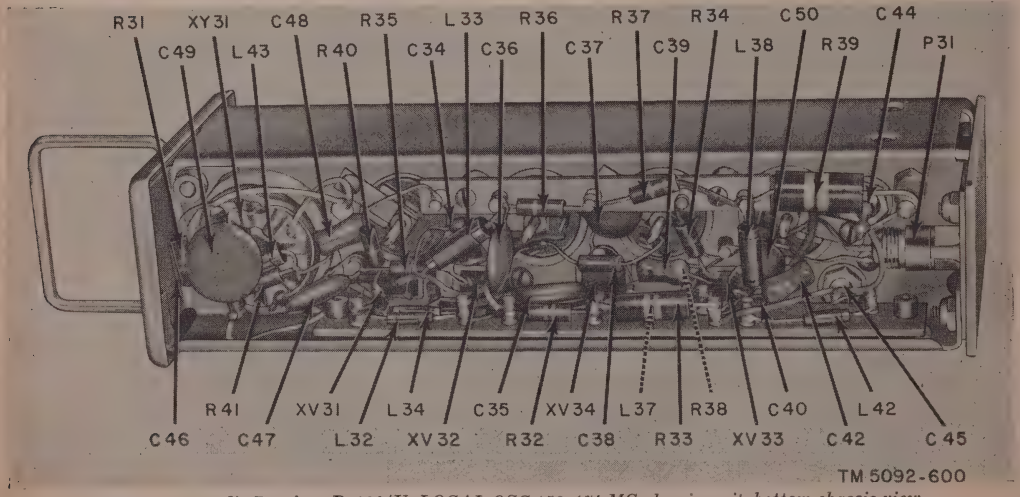

Figure 62. Radio Receiver R–394/U, LOCAL OSC 152–174 MC plug-in unit, bottom chassis view.

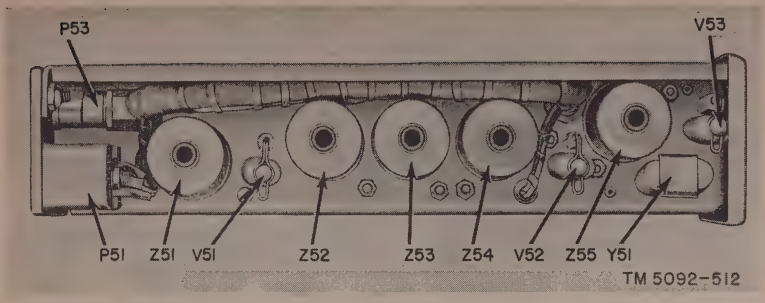

Figure 63. Radio Receiver R–394/U, 1ST IF. 7.8 MC plug-in unit, top chassis view.

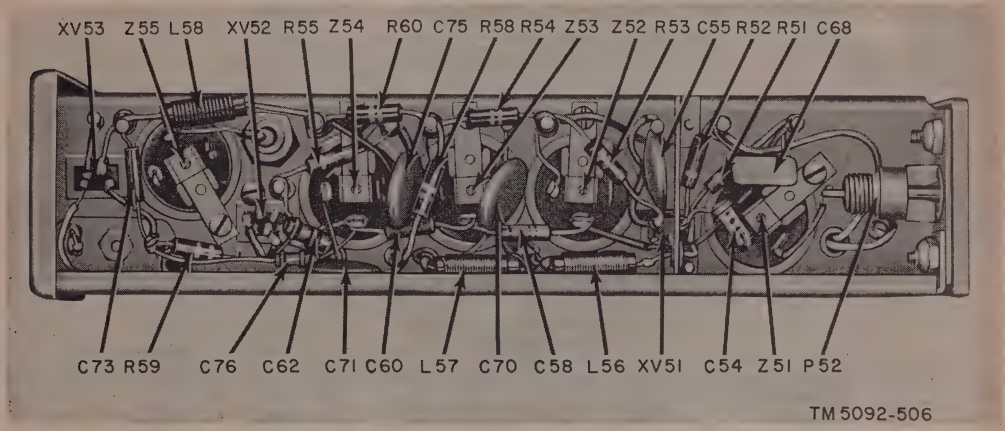

Figure 64. Radio Receiver R–394/U, 1ST IF. 7.8 MC plug-in unit, bottom chassis view.

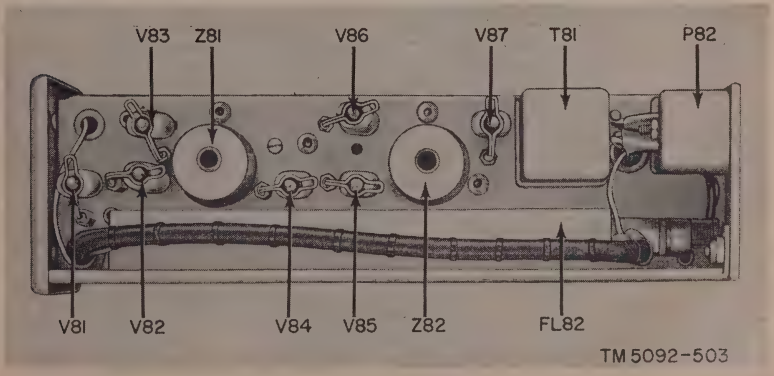

Figure 65. Radio Receiver R–394/U, 2ND IF. DISCR plug-in unit, top chassis view.

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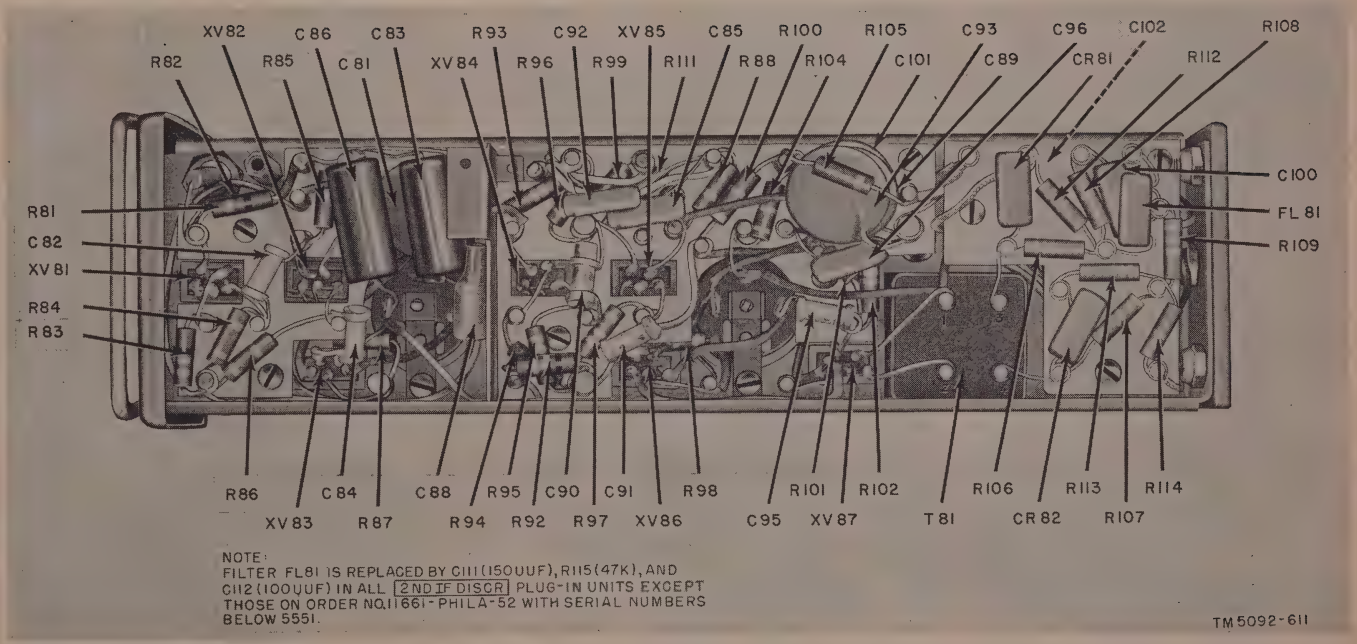

Figure 66. Radio Receiver R–394/U, 2ND IF. DISCR plug-in unit, bottom chassis view.

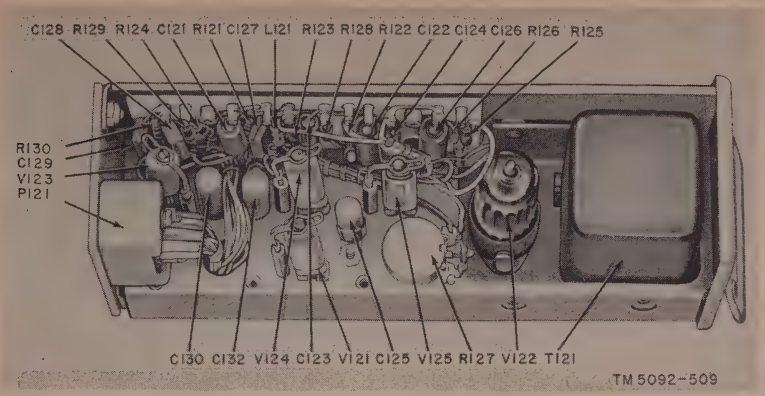

Figure 67. Radio Receiver R–394/U, AUDIO & SQUELCH plug-in unit, top chassis view.

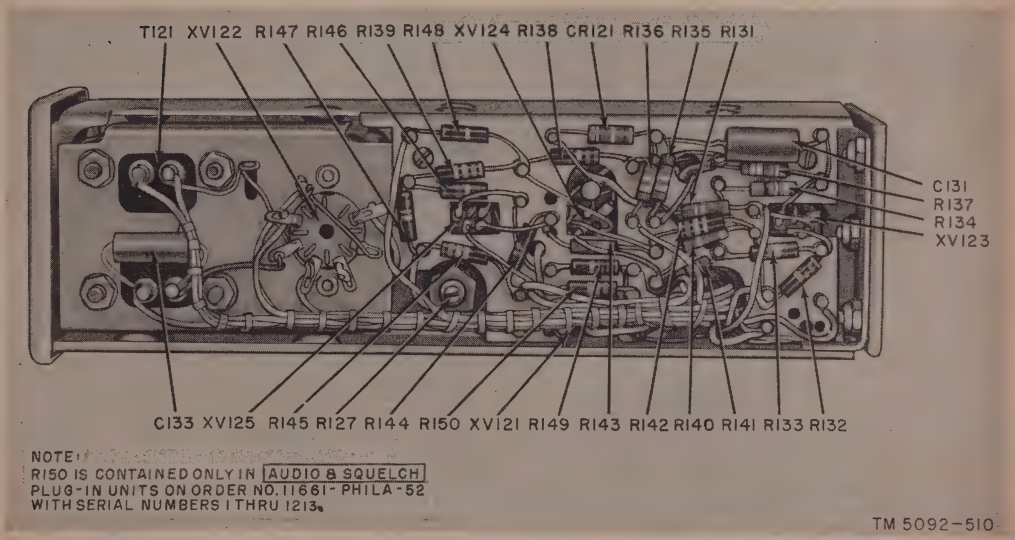
T121 XV122 R147 R146 R139 R148 XV124 R138 CR121 R136 R135 R131
C131
R137
R134
XV123
C133 XV125 R145 R127 R144 R150 XV121 R149 R143 R142 R140 R141 R133 R132
NOTE:
R150 IS CONTAINED ONLY IN AUDIO & SQUELCH
PLUG-IN UNITS ON ORDER NO. 11661-PHILA-52
WITH SERIAL NUMBERS 1 THRU 1213.
TM 5092-510

Figure 68. Radio Receiver R–394/U, AUDIO & SQUELCH plug-in unit, bottom chassis view.

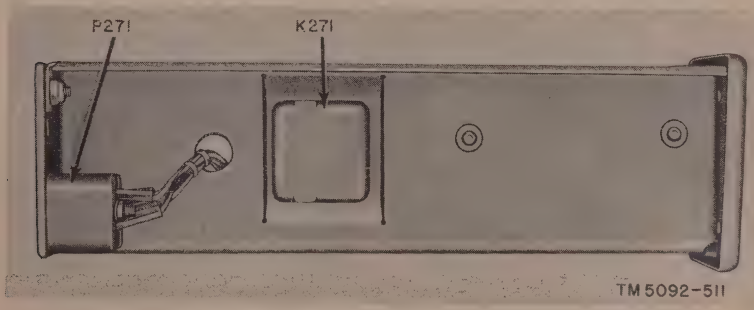

Figure 69. Radio Receiver R–394/U, RELAY plug-in unit, top chassis view.

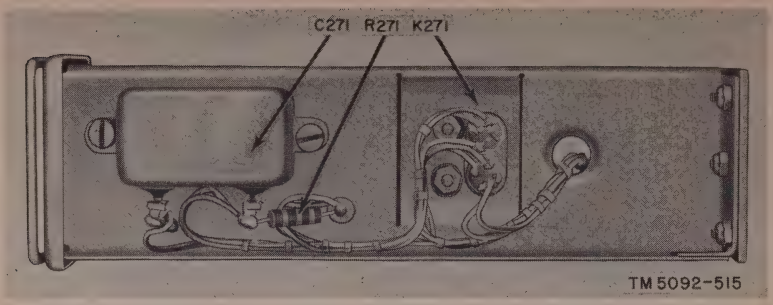

Figure 70. Radio Receiver R–394/U, RELAY plug-in unit (Receiver Subassembly MX–1547/G), bottom chassis view.

Section III. ALINEMENT AND ADJUSTMENT PROCEDURES

87. General Alinement Precautions

a. Before attempting alinement of the receiver, be certain that alinement is necessary. If the sensitivity of the receiver is below that which is required, the trouble may be caused by weak tubes or other circuit defects. If a complete alinement of the receiver is necessary, the 455-kc alinement must be done first, and then the 7.8-mc if. alinement; next, the circuits in the LOCAL OSC 152–174 MC plug-in unit; and finally, the rf circuits in the RF AMPL 152–174 MC plug-in unit. If the 455-kc if. circuits are not alined properly, subsequent alinements will be incorrect also. It is recommended that the frequency settings of the signal generator be checked with a frequency meter such as Frequency Meter TS–174B/U.

b. The RF AMPL 152–174 MC plug-in unit contains four *gimmick* capacitors, C28 through C31, which are used for adjusting the tuning range of the rf tuned circuits. These *gimmicks* are small brass tabs which are factory adjusted by varying the spacing between tabs. When performing any work on this plug-in unit, be careful not to disturb the tabs.

88. Test Equipment Required for Alinement

a. Signal Generators. The signal generator required for rf alinement such as Signal Generator SG–3/U must cover the frequency range of 152 to 174 mc and be capable of delivering a signal frequency modulated at least ±15 kc deviation with a 1,000-cps audio signal. The output should be calibrated accurately from 0 to .1 volt. The output impedance should not exceed 50 ohms. The if. signal generator (RF Signal Generator Set AN/URM–25 (TM 11–5551), Signal Generator TS–588A/U (TM 11–5018/TO 16–35TS588–5), or equivalent) should be capable of delivering the two if. frequencies, 455 kc and 7.8 mc, frequency-modulated ±15 kc (deviation) with a 1,000-cps audio signal.

b. Output Meter. The output meter used for determining the audio power output of the receiver (Output Meter TS–585B/U (TM 11–5017/TO 16–35TS585–5) or equivalent) should be set for an input impedance of 8 ohms (which matches the secondary impedance of the audio output transformer T121). Electronic Multimeter ME–6A/U (TM 11–5549) in parallel with an 8-ohm load resistor can be used in place of the output meter. The maximum audio power developed by the receiver will seldom be in excess of approximately .5 watt. Therefore, any meter that will give accurate readings from this .5 watt level down to and including zero will be satisfactory.

c. Frequency Meter. The practice of calibrating the signal generator with an accurate frequency meter, such as Frequency Meter TS–174B/U (TM 11–5044/TO 16–35TS174–5), is required. This assures accurate alinement.

d. Dc Vacuum Tube Voltmeter. A dc vacuum tube voltmeter also is required for alinement as well as troubleshooting. The hot lead should be shielded to minimize rf pick-up. This dc vtvm is used for measuring voltages across

high resistance circuits. Because of its high input impedance (over 10 megohms), the loading of the circuit by the vtvm input impedance is negligible. Electronic Multimeter TS–505/U (TM 11–5511) or equivalent is recommended for this purpose.

e. Ac Vacuum Tube Voltmeter. An ac vtvm (Electronic Multimeter ME–6/U or equivalent) is necessary for measuring audio voltages pertaining to tests and adjustment of the AUDIO & SQUELCH plug-in unit. As in the case of the dc vtvm, the high input impedance of this vtvm is highly desirable.

f. Audio Oscillator. An audio oscillator, such as Audio Oscillator TS–382A/U (TM 11–2684A) or equivalent, capable of producing audio signals from 20 to 20,000 cps, is required for testing and adjusting the AUDIO & SQUELCH plug-in unit. Audio voltages in excess of 4 volts should be obtainable from this audio oscillator.

g. Distortion Analyzer. A distortion analyzer is required to adjust the audio gain control R127 on the AUDIO & SQUELCH plug-in unit. This instrument also is required to final test the receiver. Spectrum Analyzer TS–723/U is recommended for this purpose.

h. Alinement Tool. A special alinement tool (furnished with the receiver) is required for adjusting the slugs in the various coil assemblies used in the receiver. The alinement tool has a hollow head which engages the adjusting screw in a manner which prevents the tool from slipping off the screw.

89. Alinement Procedures

a. Radio Receiver R–394/U can be alined with the receiver connected to its case with a patch cord (fig. 38). Remove the shield covers that slip over the individual plug-in units before inserting the plug-in units in the receiver base.

b. It is important to have test conditions favorable to good alinement practice. The use of a metal-topped bench, or a sheet of metal (preferably copper sheet) placed under and bonded to the receiver to be alined is considered good practice. The test equipment should be bonded to the metal sheet also. The shelter or room where the alinement is performed should be free from stray rf fields, such as are found in the vicinity of other electronic equipment. If possible, a grounded and screened room should be used. The receiver should be warmed up before the alinement begins. Fifteen minutes of warm-up time is essential; 30 minutes is desirable. The receiver power supply (Power Supply PP–846/U) should be fed from a regulated voltage supply delivering 115 volts ac. All adjustments on the receiver should be performed with nonmetallic alinement tools because metal tools may unbalance the various magnetic fields present in electronic circuits, especially in the RF AMPL 152–174 MC plug-in unit. All the alinement points in the receiver are located in the bottom sections of the plug-in units (fig. 71) and are accessible for adjustment when installed in the receiver base.

c. Set the controls on the control unit to the following positions preparatory to alinement:

(1) VOLUME control to any position clockwise so that the POWER lamp lights.

(2) SQUELCH control fully clockwise so that the squelch disable switch is in the OFF position.

Note. Changes in these settings are given when the procedure requires such changes.

90. If. Alinement Procedures

Caution: The 455-kc if. amplifiers must be alined before any other alinement is attempted. This does not apply to the frequency-changing procedure which involves realinement of the LOCAL OSC 152–174 MC or the RF AMPL 152–174 MC plug-in units.

a. 455-kc If. Alinement Procedure. Aline 455-kc if. as indicated in the chart below. If the 455-kc if. stages are far out of alinement, it may be necessary to use a large output from the signal generator to obtain an indication on the vtvm. Use a 455-kc unmodulated signal. As the tuned circuits are alined and the vtvm reading increases appreciably, decrease the signal generator output to prevent overloading. Use the lowest dc range on the vtvm. If it is not convenient to attach the signal generator to pin 4 of V52; use a junction or tie point that is connected directly to pin 4.

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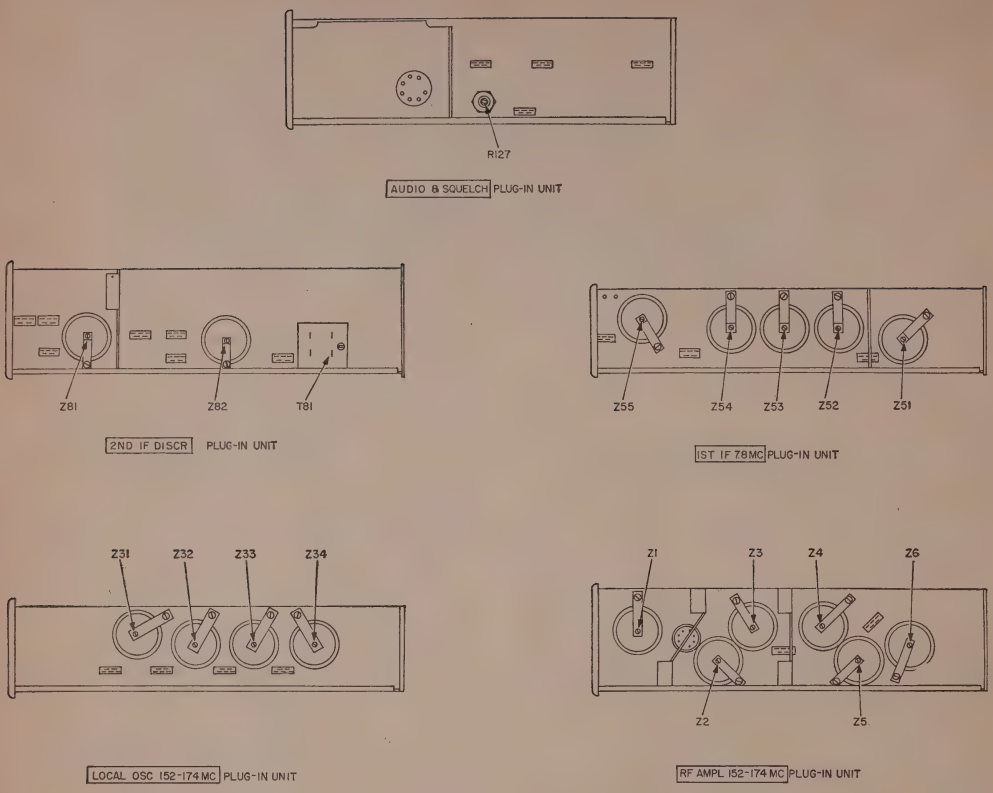

Figure 71. Radio Receiver R–394/U, alinement points.

455-kc If. Alinement Chart

Step	Vtvm connection	Signal generator connection	Adjustment	Indication
1	Test points on front of receiver marked DISCR and GND.	Pin 4 of V52 (2d mixer) through a .05-μf paper capacitor. Use approximately 100-uv output.	Discriminator T81 secondary.	+1V reading on vtvm.
2	Test point at the junction of R101 and C96 (vtvm on lowest negative range).	Pin 4 of V52 (2d mixer) through a paper capacitor. Keep output low to prevent saturation of V86.	Z82.	Maximum.
3	Test points on front of receiver marked 2ND IF. and GND.	Pin 4 of V52 (2d mixer) through a paper capacitor. Keep output low.	Z81 and Z55.	Maximum.

b. 7.8-mc If. Alinement Procedure. Before attempting the 7.8-mc if. alinement procedure, be sure the 455-kc if. stages are alined accurately. Connect the signal generator to pin 4 of V3 through a small mica capacitor and the chassis. Adjust the signal generator to 7.8 mc and check with the frequency meter. After each adjustment, reduce the signal generator output,

if necessary, to prevent overloading. If this procedure does not produce a maximum (peak) reading of the vtvm, connect the signal generator to pin 4 of V52 and adjust Z55 for maximum reading. Then connect the signal generator to pin 4 of V51 and adjust Z52, Z53, and Z54 for maximum reading. Connect the signal generator to pin 4 of V3 and adjust Z54, Z53, Z52, Z51, and Z6 for maximum reading as indicated in the chart below.

7.8-mc If. Alinement Chart

Step	Vtvm connection	Adjustments	Indications
1	Test points marked 2ND IF. and GND.	Z54, Z53, Z52, Z51 and Z6.	Maximum output.

91. Rf Alinement

a. Presetting Tuning Cores in RF AMPL 152–174 MC Plug-in Unit. The tuning cores of Z1, Z2, Z3, Z4, and Z5 first must be adjusted approximately to their correct positions to allow the signal to pass through the rf stages. The chart which follows, lists various receiver frequencies and the corresponding number of turns that the tuning cores must be adjusted for each frequency. Columns 2 and 3 list the number of turns that the core slugs must be turned *in* from the extreme counterclockwise positions. To use these two columns, the five tuning cores first must be turned to their extreme counterclockwise positions. In this position, the top of the core adjusting screw is approximately thirteen-sixteenths of an inch above the chassis. If the equipment is received directly from the factory, it is not necessary to turn all adjustments to the extreme counterclockwise positions before presetting. The receivers are tuned for 165.075 mc at the factory. Column 4 lists the direction and number of turns that the tuning cores must be changed from the factory set positions. (A spot of paint or some other type of mark on the alinement tool will make it easier to count the number of turns.)

1	2	3	4
Receiver frequency (mc)	No. of clockwise turns of turning core		No. of turns of tuning core from factory set position (Z1, Z2, Z3, Z4, and Z5)
	Z1, Z2, Z4	Z3, Z5	
152	7	9	10 out (counterclockwise)
153	8	10	9 out (counterclockwise)
154	9	11	8 out (counterclockwise)
155	10	12	7 out (counterclockwise)
156	10¾	12¾	6¼ out (counterclockwise)
157	11½	13½	5½ out (counterclockwise)
158	12¼	14¼	4¾ out (counterclockwise)
159	13	15	4 out (counterclockwise)
160	13¾	15¾	3¼ out (counterclockwise)
161	14½	16½	2½ out (counterclockwise)
162	15¼	17¼	1¾ out (counterclockwise)
163	15¾	17¾	1¼ out (counterclockwise)
164	16½	18½	½ out (counterclockwise)
165	17	19	0
166	17¾	19¾	¾ in (clockwise)
167	18½	20½	1½ in (clockwise)
168	19¼	21¼	2¼ in (clockwise)
169	20¼	22¼	3¼ in (clockwise)
170	21	23	4 in (clockwise)
171	21¾	23¾	4¾ in (clockwise)
172	22½	24½	5½ in (clockwise)
173	23¼	25¼	6¼ in (clockwise)
174	24	26	7 in (clockwise)

b. RF AMPL 152–174 MC Alinement. The signal generator is connected to the antenna coaxial connector and ground. A vtvm is used at the 2ND IF. and GND test points located at the front of the receiver. If the rf alinement needs considerable adjustment, the signal generator output may have to be quite high. Reduce the signal generator output when necessary to keep the vtvm reading on the scale. Proceed as follows:

Step	Vtvm connection	Adjustments	Indications
1	Test points on front of receiver marked 2ND IF. and GND.	Z1, Z2, Z3, Z4, and Z5.	Maximum negative output.
2	Test points on front of receiver marked 2ND IF. and GND.	Repeat step 1 at least 3 times.	Maximum negative output.

c. LOCAL OSC 152–174 MC Alinement.

(1) Aline the LOCAL OSC 152–174 MC plug-in unit, as follows:

Step	Vtvm connection	Adjustments	Indications
1	None.	Z31 unscrewed almost all the way counterclockwise.	None.
2	R40 at terminal on TB31 and GND test point.	Z31.	Maximum negative voltage.
3	R34 at terminal on TB31 and GND test point.	Z32 and Z33.	Maximum negative voltage.
4	LO and GND test points.	Z34.	Maximum negative voltage.

d. Adjusting Receiver to Transmitter Frequency. At this point, it is possible to adjust the receiver frequency to the transmitter frequency by adjusting warping coil Z31 which shifts the receiver frequency a few kilocycles in either direction. This feature compensates for slight variations in crystals and alinement. Adjust warping coil Z31 as follows:

Vtvm connection	Signal generator connection	Adjustment
Test points on front of receiver marked DISCR and GND.	No signal generator used. Turn on the transmitter. (Set to the desired frequency.)	Adjust Z31 for a zero reading on the vtvm.

Note. The resonant frequency of some crystals may be higher than their nominal rated frequencies. When one of these crystals is *warped* (by adjustment of Z31) to the desired frequency, the frequency of oscillation may be considerably lower than the natural frequency of the crystal. Under these conditions, the oscillator may not oscillate once the receiver is turned off and later turned on. Therefore, turn the receiver off and then on at least once after the final adjustment of the LOCAL OSC 152–174 MC plug-in unit. If the oscillator fails to function subsequent to this test, replace crystal Y31 with one that will give satisfactory operation. (Crystal Y31 is a type CR–32/U.)

92. Crystal Insertion

a. Removal of Crystal. Crystal oven E31 contains crystal Y31 (a type CR–32/U), thermostat S31, and a dual heater winding which can be operated from 6.3 volts ac or dc or from 24 volts dc. Disassemble this oven as follows (fig. 72):

(1) Remove crystal oven E31 from the LOCAL OSC 152–174 MC plug-in unit.

(2) Loosen and remove the three binder head screws from the shell and remove the shell.

(3) Lift the heater winding off octal base E37.

(4) The crystal and the thermostat can now be removed. Since the crystal and the thermostat are similar in appearance, they can be reversed accidentally. The thermostat is colored black to distinguish it from the crystal. The crystal has its third overtone frequency marked on it. A decal fastened to the LOCAL OSC 152–174 MC plug-in unit near the octal oven socket also

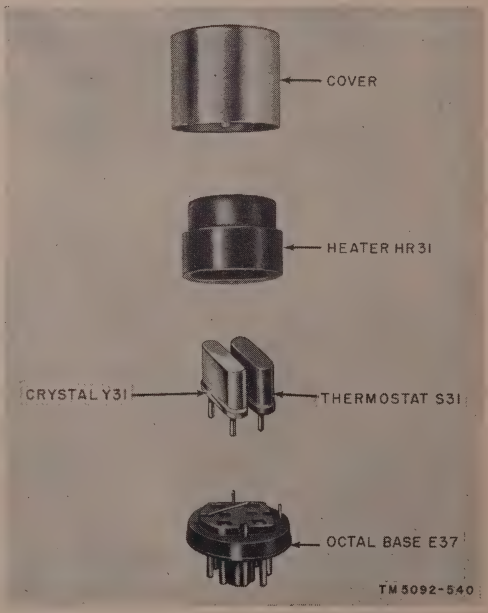

Figure 72. Radio Receiver R–394/U, crystal oven shown disassembled.

will guide the serviceman in returning the crystal and thermostat to their correct locations.

b. Crystal Selection. The selection of the proper crystal is made by the use of this formula:

$$\text{Crystal frequency (mc)} = \frac{\text{Receiver frequency (mc)} - 7.8 \text{ mc.}}{6}$$

c. Reassembling Crystal Oven.

(1) Plug the crystal and thermostat into the octal oven base.

(2) Slip the dual heater winding over the crystal and thermostat, observing the location of the contact pins and their proper holes in the octal base.

(3) Replace the cover and the three binder head screws.

(4) Plug the crystal oven into the octal socket in the LOCAL OSC 152–174 MC plug-in unit.

93. Adjustment of Audio Volume Control

If it becomes necessary to readjust audio volume control M127 (fig. 71), proceed as follows:

a. Connect Signal Generator SG–3/U (or equivalent), frequency-modulated ± 15 kc with 1,000 cps and tuned to the frequency of the receiver, to P1 on the RF AMPL 152–174 MC plug-in unit.

b. Connect a vtvm to the front panel test points marked DISCR and GND, and tune the signal generator to the receiver frequency.

c. Connect an audio output meter (set for 8-ohm load) and a distortion analyzer to the speaker output terminals.

d. Adjust R127 so that the receiver output is .5 watt. (If an ac voltmeter and an 8-ohm load resistor are used across the speaker output terminals instead of the output meter, the voltmeter reading should be 2 volts.) The harmonic distortion should not exceed 10 percent.

Section IV. FINAL TESTING

94. General

This section is intended as a guide to be used in determining the quality of a repaired Radio Receiver R–394/U. The minimum test requirements outlined in paragraphs 95 through 105 may be performed by maintenance personnel with adequate test equipment and the necessary skills. Repaired equipment meeting these requirements will furnish uniformly satisfactory operation.

95. Test Equipment Required for Final Testing

The instruments needed for final testing of Radio Receiver R–394/U are listed below:

a. Signal Generator. An fm signal generator capable of producing signals frequency-modulated ± 15-kc (deviation) with a 1,000-cps audio tone is required for the rf alinement of the receiver. In addition, the attenuator should be calibrated so that the output voltage can be determined accurately. Signal Generator SG–3/U or equivalent (par. 66) is required for this purpose. A signal generator, such as RF Signal Generator Set AN/URM–25 (or Signal Generator TS–588/U), also is required for testing the 7.8-mc if. amplifier and the 455-kc if. amplifiers and limiters.

b. Output Meter. An output meter such as Output Meter TS–585/U or equivalent is required for measuring the audio power output of the receiver. The impedance of this meter must match the 8-ohm output impedance of the receiver. An ac vtvm with an 8-ohm resistor across the output of the receiver also can be used for determining power output.

c. Ac and Dc Vacuum Tube Voltmeters. A dc vtvm such as Electronic Multimeter TS–505/U, or equivalent, and an ac vtvm such as Electronic Multimeter ME–6A/U, or equivalent, are required for various tests. Electronic voltmeters generally are preferred because of their high input impedance which practically eliminates circuit loading.

d. Audio Oscillator. An audio oscillator such as Audio Oscillator TS–382A/U, or equivalent, is satisfactory for producing audio signals from 20 to 20,000 cps and having a voltage amplitude of at least 10 volts.

e. Distortion Analyzer. A distortion analyzer such as Spectrum Analyzer TS–723/U or

equivalent, is required for accurately measuring audio distortion.

96. Standard Test Conditions

a. General. Final testing will be performed under "standard test condition" unless other directions are given. For Radio Receiver R–394/U, these conditions are as follows:

(1) Audio output shall be .5 watt at the output terminals of the audio output transformer.

(2) Quieting sensitivity shall be at least 20 decibels (*db*).

(3) Signal-plus-noise to noise ratio shall be at least 10 *db*.

(4) Input voltage shall be 6.3, 12.6, 26.2 volts dc or 115 volts or 230 volts at 60 cps, depending on the receiver power supply used.

(5) Temperature and humidity shall be 59° F. to 86° F. with 50- to 70-percent relative humidity.

(6) Warm-up period shall be at least 15 minutes.

b. Controls. Set the controls on the control unit at the following positions unless other instructions are given:

(1) VOLUME control fully clockwise from the OFF position.

(2) SQUELCH control fully clockwise so that the squelch disable switch is in the OFF position.

(3) Audio volume control R127 turned fully clockwise for maximum gain.

c. Test Set-up. Figure 73 shows a typical set-up of equipment for final testing.

(1) Connect the rf signal generator to antenna connector P1 on the RF Amplifier 152–174 MC plug-in unit.

(2) Connect the output meter (set for 8-ohm load) across the secondary of T121. Connect a distortion analyzer to the same points.

d. Units of Measure. When meter scales are not calibrated in decibels, power ratios and voltage ratios can be converted into decibels by substituting the units in the following formulas:

(1) $Db = 10 \log \frac{P2}{P1}$, where P_1 and P_2 are the two units of power in watts to be compared. For example:

Let $P_2 = 50$ watts, and $P_1 = 10$ watts.

Then $db = 10 \log \frac{P2}{P1} = 10 \log \frac{50}{10}$

$= 10 \times \log 5 = 10 \times .70 = 7.0$ *db*.

(2) $Db = 20 \log \frac{E_2}{E_1}$, where E_1 and E_2 are two voltages (across the same or equal resistances) to be compared. For example:

Let $E_2 = 50$ volts and $E_1 = 2$ volts.

Then $db = 20 \log \frac{E_2}{E_1} = 20 \log \frac{50}{2}$

$= 20 \times \log 25 = 20 \times 1.40 = 28$ *db*.

(3) When two meter readings are obtained directly in decibels, the *db* gain (or loss) is calculated by subtracting the lower *db* reading from the higher one.

97. Sensitivity

a. The sensitivity of the receiver is measured at the low end, the high end, and the middle of the frequency band. Sensitivity is defined as the signal (number of microvolts) necessary to produce a signal-plus-noise to noise ratio of 10 *db*.

b. Determine the sensitivity of the receiver by measuring the lowest signal generator input with 1,000-cps ±15-kc modulation that will give a 10-*db* signal-plus-noise to noise ratio. The signal generator input voltage should be no greater than .5 uv.

(1) Connect the signal generator to antenna connector P1 and apply a .5-uv ±15-kc fm signal with a 1,000-cps tone. Note the reading on the output meter.

(2) Turn off the signal generator modulation. The reading on the output meter should be at least 10 *db* lower than that obtained in *b*(1) above.

98. Power Output and Distortion

a. The power output and distortion test is used to determine how much audio power can be developed with a specified percentage of allowable distortion.

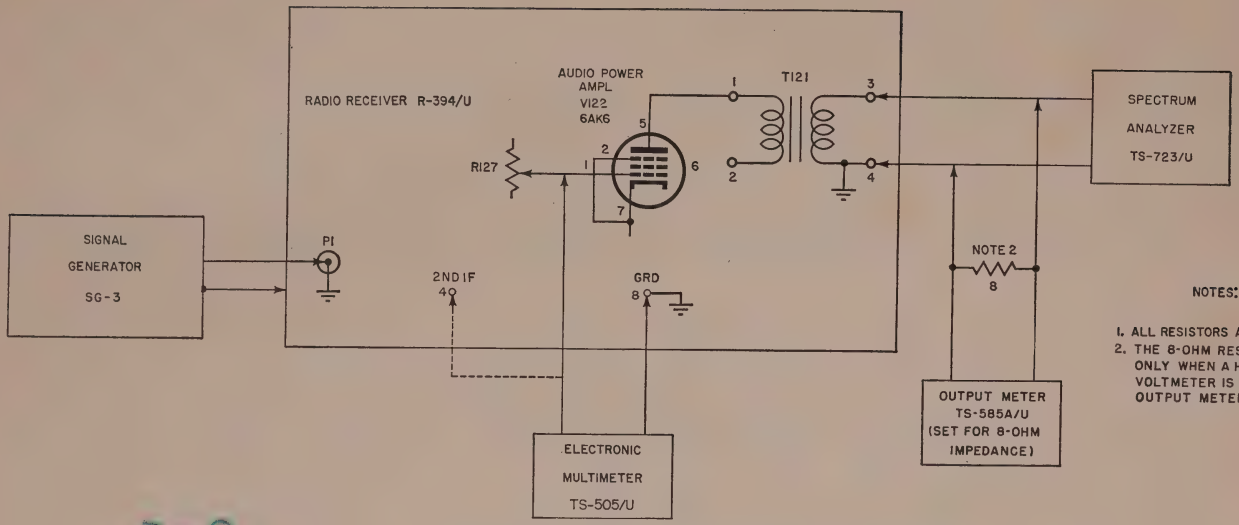

Figure 73. Final test set-up for Radio Receiver R-394/U.

KKK/AAHKZ
CHES WATKINS
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FT. PIERCE, FLA

b. Use the standard test conditions (par. 96) with audio volume control R127 turned fully clockwise (maximum gain). Apply a 100-uv (1,000-cps) ±15-kc fm signal to P1 with the signal generator.

c. The power output must be at least .5 watt with the distortion not exceeding 10 percent. If the distortion as indicated on the distortion analyzer exceeds 10 percent, slowly turn R127 counterclockwise until the distortion is exactly 10 percent. At this point the power output must equal or exceed .5 watt.

99. Overall Audio Frequency Response

a. The overall audio frequency response (fig. 74) of the receiver is designed to favor voice communication. A de-emphasis circuit preceding the first audio amplifier attenuates the high frequency audio signals at the rate of 6 *db*±1 *db* per octave.

b. Apply a 100-uv fm signal modulated ±15 kc with a 1,000-cps audio signal to antenna connector P1. Use this audio output figure as a 0–*db* reference level and make a frequency response test at audio frequencies between 100 cps and 4,000 cps. The response should agree with the following values within 1 *db*.

Frequency (cps)	100	300	500	1,000	2,000	2,500	4,000
Response (*db*)	17.5	10	6	0	—6	—8	—13.2

c. The chart indicates the overall receiver audio response. The reference point, 0 *db*, is taken at 1,000 cps.

100. Image Rejection Ratio

a. In Radio Receiver R–394/U, the local oscillator frequency is 7.8 mc lower than the signal frequency to which the rf amplifiers are tuned. The beating of these two signals in the mixer stage produces an if. of 7.8 mc. However, a signal 7.8 mc lower than that of the local oscillator (or 15.6 mc lower than that of the desired receiver input signal) will beat also with the local oscillator signal in the mixer stage to produce an if. of 7.8 mc. The tuned circuits of the rf amplifiers must reject this image signal. For example, if the desired rf signal is 165 mc, then the undesired image frequency is 165–15.6, which equals 149.4 mc.

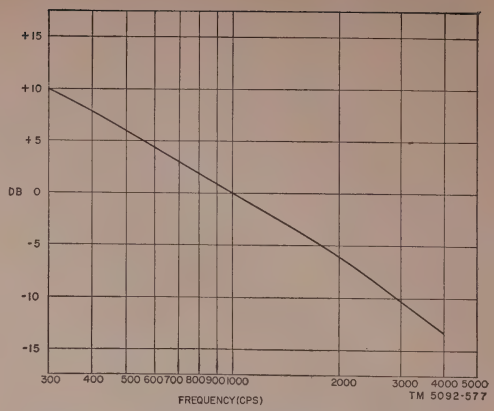


Figure 74. Radio Receiver R–394/U, overall audio frequency response curve.

b. With no signal applied to the radio set, note the reading on the output meter. This is caused by noise. Determine the image frequency as outlined in *a* above and accurately tune the signal generator to this frequency. Turn on the signal generator and adjust the output for 20 *db* quieting. Record the output voltage of the signal generator.

c. Repeat the above step, but tune the signal generator to the receiver frequency. Record the generator output for this step and compare it with the value obtained in *b* above. The ratio of these two input voltages is the image rejection ratio. This image rejection ratio should not be less than 31,620 (90 *db*). Image rejection ratio $= \frac{\text{uv (from } b\text{)}}{\text{uv (from } c\text{)}}$

101. If. Rejection Ratio

a. Signals that reach the antenna and are of the same frequencies as the if. stages of the receiver may be passed by the receiver and produce interference to normal reception. The two rf amplifiers in this receiver, V1 and V2, are designed to provide a high rejection ratio of these 7.8-mc and 455-kc signals. The ratio of the input signals at the if. frequency and the receiver frequency required to give 20-*db* quieting is the if. rejection ratio.

b. Adjust the signal generator to deliver an unmodulated 455-kc signal to the antenna input and to give 20 *db* quieting at the output meter. Record the signal generator output.

c. Adjust the signal generator to deliver 7.8 mc to the antenna input and to give 20-*db* quieting. Record the signal generator output.

d. Adjust the signal generator to the receiver frequency and adjust the signal generator output to give 20-*db* quieting. Record the signal generator output.

e. 455 kc if. rejection ratio = $\frac{\text{uv (from } b)}{\text{uv (from } d)}$

7.8 mc if. rejection ratio = $\frac{\text{uv (from } c)}{\text{uv (from } d)}$

The if. rejection ratio should be at least 31,620 (90 *db*).

102. Adjacent and Alternate Channel Selectivity

a. Adjacent and alternate channel selectivity is a measure of the ability of the receiver to reject signals existing on frequencies 50 kc and 100 kc removed from the receiver frequency. The adjacent channel frequency shall be attenuated at least 80 *db* below the receiver frequency, and the alternate channel frequency shall be attenuated at least 90 *db* below the receiver frequency. These tests are performed by comparing the signal injected from a signal generator at the receiver frequency with the signal injected at the adjacent or alternate channel frequency which will produce the same output from the recevier.

b. Since the signal generator output is measured as a voltage, *db* units must be substituted for a voltage ratio (par. 96*d*); 80 *db* corresponds to a voltage ratio of 10,000 and 90 *db* corresponds to a voltage ratio of 31,620.

c. Procedure for determining adjacent and alternate channel selectivity is as follows:

(1) Connect a dc vtvm between the test points on the front of the receiver marked 2ND IF. and GND. With the signal generator tuned to the receiver frequency with no modulation and zero output, observe the vtvm reading (resulting from receiver noise).

(2) Carefully increase the output of the signal generator until the reading on the vtvm shows a small increase. Switch the signal generator on and off several times to be sure the increased vtvm reading is the result of the applied signal. Do not set the signal generator output any higher than necessary to obtain the small increased indication. Record the output of the signal generator and the reading on the vtvm.

(3) Shift the signal generator frequency above the receiver frequency 50 kc and increase the signal generator output so that the vtvm reading obtained in (2) above is duplicated. Repeat the same operation at a frequency 50 kc below the receiver frequency. The signal generator output required for duplicating the vtvm reading obtained in (2) above should be similar for adjacent channel frequencies (50 kc) above and below the receiver frequency and increased at least 80 *db*, a voltage ratio of 10,000 to 1.

(4) Repeat the procedure in (3) above, but tune the signal generator to alternate channel frequencies (100 kc) above and below the receiver frequency. The alternate channel selectivity should be at least 90 *db*, a voltage ratio of 31,620 to 1.

103. Squelch Test

a. This test is designed to determine whether the squelch circuit sensitivity is adequate. The test measures the ratio between the receiver noise with the squelch circuit disabled and no signal input and the receiver noise resulting from the minimum signal required to squelch the receiver when the squelch control is set in a position of maximum sensitivity.

b. Use the following procedure to test the squelch circuit:

(1) Tune the signal generator to the receiver frequency with no modulation and zero output.

(2) Connect a dc vtvm to pin 1 of audio output tube V122. Set the selector switch of the vtvm to —DC.

(3) Connect the output meter (set for 8-ohm load) across terminals 3 and 4 of audio output transformer T121.

(4) With the SQUELCH control at OFF (maximum clockwise position) and zero output from the signal generator record the output meter reading in decibels.

(5) Turn the SQUELCH control counterclockwise slowly and stop at the point where the audio circuits become squelched, as indicated by a reading of approximately —25 volts on the vtvm.

(6) Advance the output of the signal generator slowly until the vtvm reading drops to almost zero. The receiver is again unsquelched. Take a reading on the output meter.

(7) Determine the squelch sensitivity as follows:
Squelch sensitivity (*db*) = *db* (from step (4)) - *db* (from step (6)). The squelch sensitivity should be less than 10 *db*.

104. Overall Receiver Selectivity

a. General. The overall selectivity of the receiver is a measure of the band pass characteristics from antenna connector P1 to the output terminals. Since the audio stages have a fixed response, output measurements in this test are taken at the grid of the fifth 455-kc if. amplifier. This test compares the receiver gain at resonance and at frequencies off resonance.

b. Procedure for Determining Receiver Selectivity.

(1) Connect a dc vtvm between the front test points of the receiver marked 2ND IF. and GND. With the signal generator tuned to the receiver frequency with no modulation and zero output, observe the vtvm reading (resulting from receiver noise).

(2) Carefully increase the output from the signal generator until the reading on the vtvm shows a small increase. Record this reading. Switch the signal generator on and off several times to be sure that the increased vtvm reading is the result of the applied signal. Do not set the signal generator output any higher than necessary to obtain the increased indication. Record the output of the signal generator and the reading on the vtvm.

(3) Shift the signal generator frequency above the receiver frequency 15 kc and increase the signal generator output so that the vtvm reading in (2) above is duplicated. Repeat the same operation at a frequency 15 kc below the receiver frequency. The signal generator output for frequencies above the receiver frequency should be similar to the output below the receiver frequency and twice the signal generator output recorded from (2) above (6 *db*).

(4) Repeat the procedure in (3) above, but shift to frequencies 35 kc above and below the receiver frequency. The ratio between the signal generator output required for this procedure (2) above should be approximately 31,620 (90 *db*). Figure 75 shows a typical overall frequency response curve of a properly functioning receiver.

105. Discriminator Test

a. General. The discriminator test gives an indication of proper discriminator operating conditions as shown graphically in figure 30. The input signal to this stage is varied above and below the second if. of 455 kc and the dc output of the discriminator is measured.

b. Procedure for Discriminator Test.

(1) Connect a dc vtvm between ground and the junction of C96 and R101, the test point from the grid of second limiter V87. Tune the if. signal generator to 455 kc, without modulation, and feed the output through a small mica capacitor (approximately 1,000 $\mu\mu$f) to the control grid of the second mixer V52 and ground. Adjust the output of the signal generator to give an approximate vtvm reading of —25 volts. Move the vtvm to the front panel test points marked DISCR and GND. The discriminator output should be +1 volt when properly alined.

(2) Carefully tune the signal generator below 455 kc to that frequency which gives a maximum negative indication on the vtvm. Carefully tune back and forth through this point to be sure the setting of the signal generator gives the maximum vtvm indication.

Figure 75. Overall selectivity curve of Radio Receiver R–394/U.

Record this reading. Do the same for the frequency above 455 kc which gives a maximum positive indication on the vtvm. The points of maximum positive and negative indications must be at least 35 kc removed from 455 kc (420 and 490 kc).

(3) Tune the signal generator to 440 kc and record the vtvm reading. Both readings should be a minimum of 7 volts removed from the original +1 volt reading (+8 volts and —6 volts). The change in discriminator output voltage produced by the 440-kc signal must not differ from that produced by the 470-kc signal by more than 3 volts.

(4) Tune the signal generator to 420 kc and 490 kc, and record the discriminator output voltages (as in (2) above). The readings of both polarities on the vtvm should be a minimum of 14 volts removed from the original +1 volt reading (+15 volts and —13 volts). The change in discriminator output voltage produced by the 420-kc signal must not differ from that produced by the 490-kc signal by more than 6 volts.

(5) If the minimum requirements given in (2), (3), and (4) above are not obtained, the discriminator stage requires realinement, repair, or replacement.

CHAPTER 6

SHIPMENT AND LIMITED STORAGE AND DEMOLITION TO PREVENT ENEMY USE

106. Repacking for Shipment or Limited Storage

a. The exact procedure used in repacking for shipment or limited storage depends on the material available and the conditions under which the equipment is to be shipped or stored. Refer to paragraph 12 and reverse the unpacking instructions as far as practicable.

b. Whenever practicable, place a dehydrating agent, such as silica gel, inside the case or carton which contains the receiver. Protect it with a waterproof paper barrier. Seal the seams with sealing compound or tape. Provide at least 3 inches of excelsior padding between the paper barrier and packing case.

107. Demolition of Materiel to Prevent Enemy Use

The demolition procedures outlined in paragraph 108 will be used to prevent the enemy from using or salvaging this equipment. Demolition of the equipment will be accomplished only on order of the commander.

108. Methods of Destruction

a. Smash. Smash the crystals, controls, tubes, coils, switches, capacitors, and transformers; use sledges, axes, handaxes, hammers, crowbars, or other heavy tools.

b. Cut. Cut cords and wiring; use axes, handaxes, or machetes.

c. Burn. Burn cords, resistors, capacitors, coils, wiring, and technical manuals; use gasoline, kerosene, oil, flame throwers, or incendiary grenades.

d. Bend. Bend panels, cabinet, and chassis.

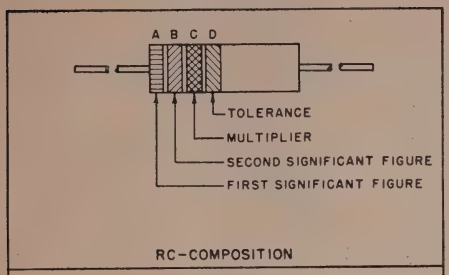
e. Explosives. If explosives are necessary, use firearms, grenades, or TNT.

f. Disposal. Burn or scatter the destroyed parts in slit trenches, fox holes, or other holes, or throw them into streams.

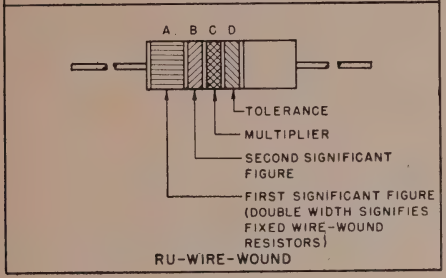
g. Destroy. Destroy everything.

RESISTOR COLOR CODE MARKING
(MIL-STD RESISTORS)

AXIAL-LEAD RESISTORS (INSULATED)

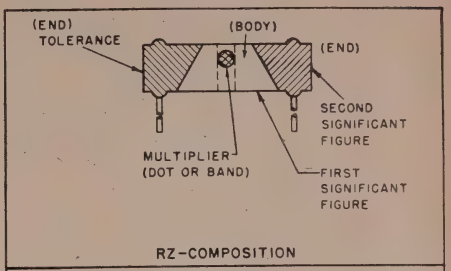


RC-COMPOSITION

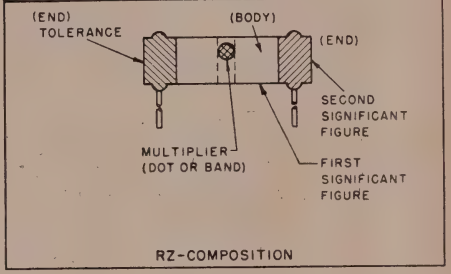


RU-WIRE-WOUND

RADIAL-LEAD RESISTORS (UNINSULATED)



RZ-COMPOSITION



RZ-COMPOSITION

RESISTOR COLOR CODE

BAND A OR BODY*		BAND B OR END*		BAND C OR DOT OR BAND*		BAND D OR END*	
COLOR	FIRST SIGNIFICANT FIGURE	COLOR	SECOND SIGNIFICANT FIGURE	COLOR	MULTIPLIER	COLOR	RESISTANCE TOLERANCE (PERCENT)
BLACK	0	BLACK	0	BLACK	1	BODY	± 20
BROWN	1	BROWN	1	BROWN	10	SILVER	± 10
RED	2	RED	2	RED	100	GOLD	± 5
ORANGE	3	ORANGE	3	ORANGE	1,000		
YELLOW	4	YELLOW	4	YELLOW	10,000		
GREEN	5	GREEN	5	GREEN	100,000		
BLUE	6	BLUE	6	BLUE	1,000,000		
PURPLE (VIOLET)	7	PURPLE (VIOLET)	7				
GRAY	8	GRAY	8	GOLD	0.1		
WHITE	9	WHITE	9	SILVER	0.01		

*FOR WIRE-WOUND-TYPE RESISTORS, BAND A SHALL BE DOUBLE-WIDTH. WHEN BODY COLOR IS THE SAME AS THE DOT (OR BAND) OR END COLOR, THE COLORS ARE DIFFERENTIATED BY SHADE, GLOSS, OR OTHER MEANS.

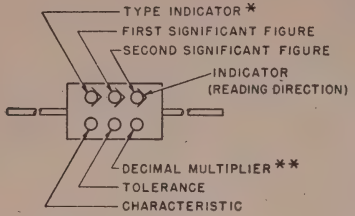
EXAMPLES (BAND MARKING):
10 OHMS ±20 PERCENT: BROWN BAND A; BLACK BAND B; BLACK BAND C; NO BAND D.
4.7 OHMS ±5 PERCENT: YELLOW BAND A; PURPLE BAND B; GOLD BAND C; GOLD BAND D.

EXAMPLES (BODY MARKING):
10 OHMS ±20 PERCENT: BROWN BODY, BLACK END; BLACK DOT OR BAND; BODY COLOR ON TOLERANCE END.
3,000 OHMS ±10 PERCENT: ORANGE BODY, BLACK END, RED DOT OR BAND; SILVER END.

STD-RI

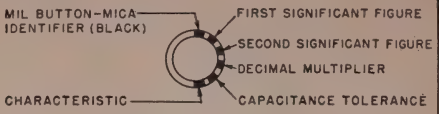
Figure 76. Resistor color codes.

CAPACITOR COLOR CODE MARKING
(MIL-STD CAPACITORS)

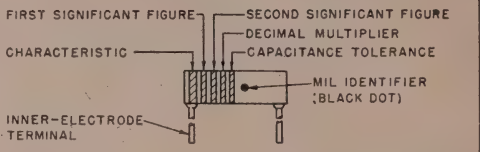


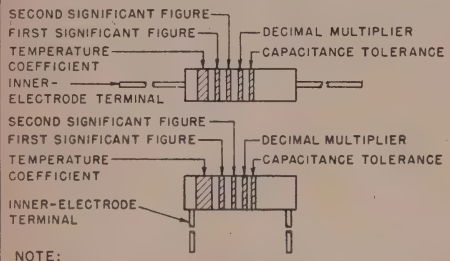
* BLACK DOT: MICA DIELECTRIC
SILVER DOT: PAPER DIELECTRIC
** INDICATES NUMBER OF ZEROS ON PAPER TYPE.

MICA (CM) AND PAPER (CN)



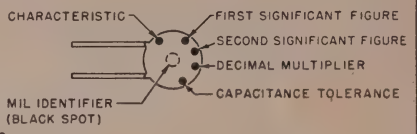
BUTTON-MICA (CB)





NOTE:
SPOTS MAY BE USED INSTEAD OF BANDS; TEMPERATURE COEFFICIENT MARKING IS LARGER.

CERAMIC-TEMPERATURE COMPENSATING (CC)



NOTES:
1. SPOTS MAY BE USED ON TUBULAR CAPACITORS; CHARACTERISTIC SPOT IS LARGER AND MIL IDENTIFIER IS ON SIDE DIAMETRICALLY OPPOSITE COLOR SPOTS.
2. MIL IDENTIFIER OF DISK TYPE IS ON REVERSE SIDE; CHARACTERISTIC SPOT IS LARGER OR SPACE BETWEEN CHARACTERISTIC AND TOLERANCE SPOTS IS THREE TIMES SPACE BETWEEN ADJACENT SPOTS.
3. TOLERANCE: YELLOW, +100%, -20%

CERAMIC-GENERAL PURPOSE (CK)

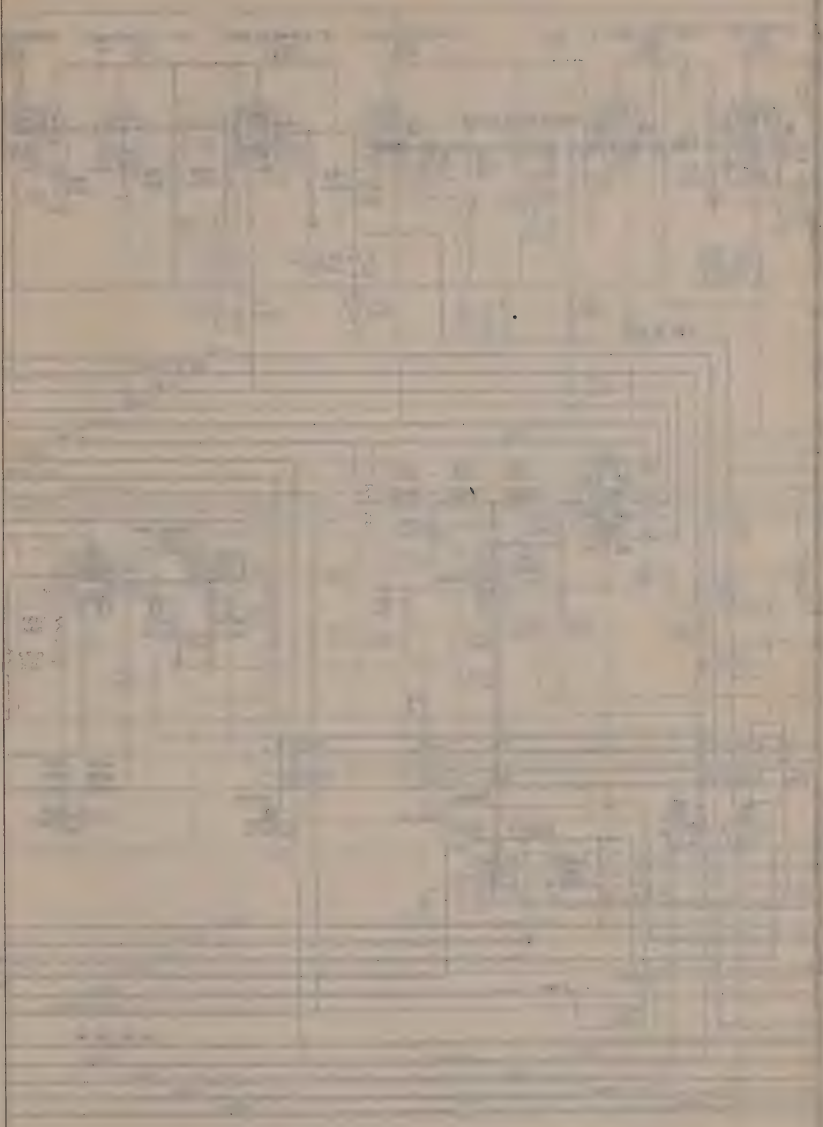
CAPACITOR COLOR CODE

COLOR	SIG FIG.	MULTIPLIER		CHARACTERISTIC[1]				TOLERANCE[2]					TEMPERATURE COEFFICIENT (UUF/UF/°C)
		DECIMAL	NUMBER OF ZEROS	CM	CN	CB	CK	CM	CN	CB	CC		
											OVER 10UUF	10UUF OR LESS	CC
BLACK	0	1	NONE		A			20	20	20	20	2	ZERO
BROWN	1	10	1	B	E	B	W				1		-30
RED	2	100	2	C	H		X	2		2	2		-80
ORANGE	3	1,000	3	D	J	D			30				-150
YELLOW	4	10,000	4	E	P								-220
GREEN	5		5	F	R						5	0.5	-330
BLUE	6		6		S								-470
PURPLE (VIOLET)	7		7		T	W							-750
GRAY	8		8			X						0.25	+30
WHITE	9		9								10	1	-330(±500)[3]
GOLD		0.1						5		5			+100
SILVER		0.01						10	10	10			

1. LETTERS ARE IN TYPE DESIGNATIONS GIVEN IN MIL-C SPECIFICATIONS.
2. IN PERCENT, EXCEPT IN UUF FOR CC-TYPE CAPACITORS OF 10 UUF OR LESS.
3. INTENDED FOR USE IN CIRCUITS NOT REQUIRING COMPENSATION.

STD-CI

Figure 77. Capacitor color codes.



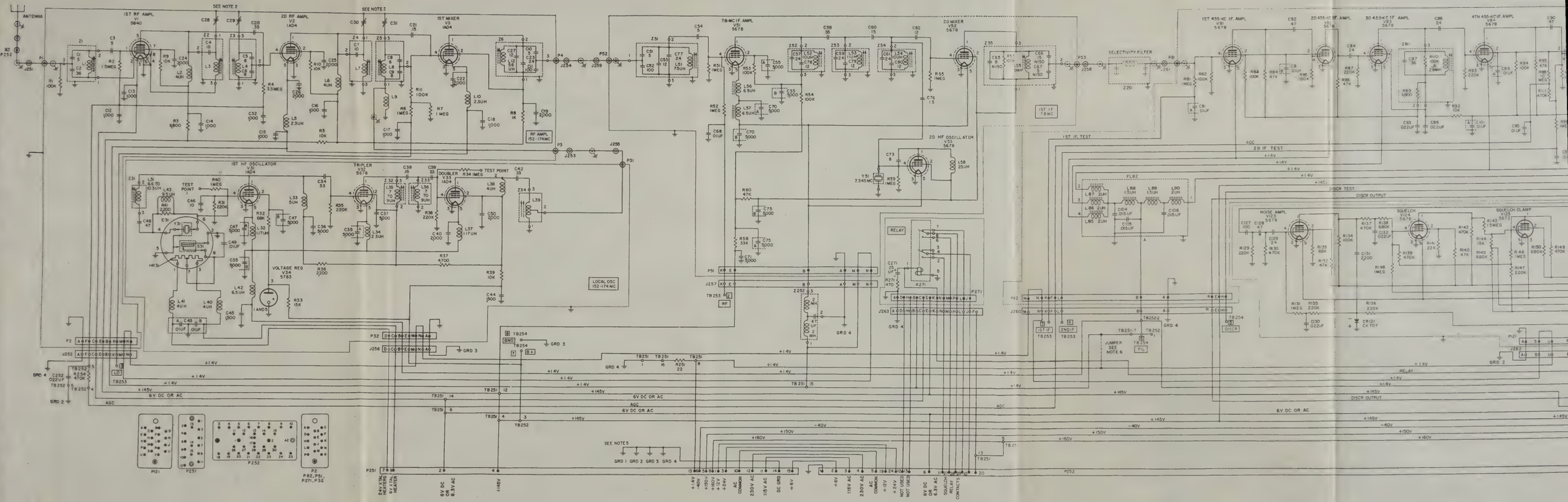


Figure 78. Radio Receiver R-394/U, schematic diagram.

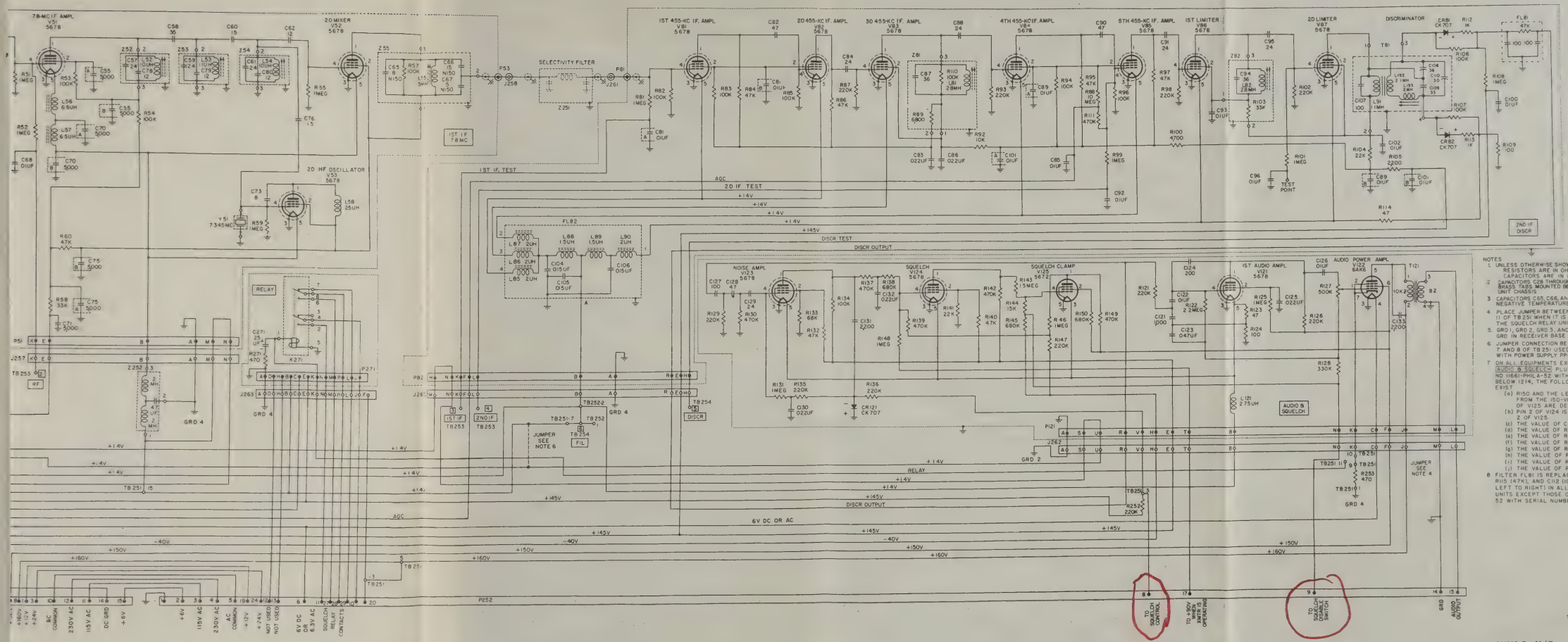


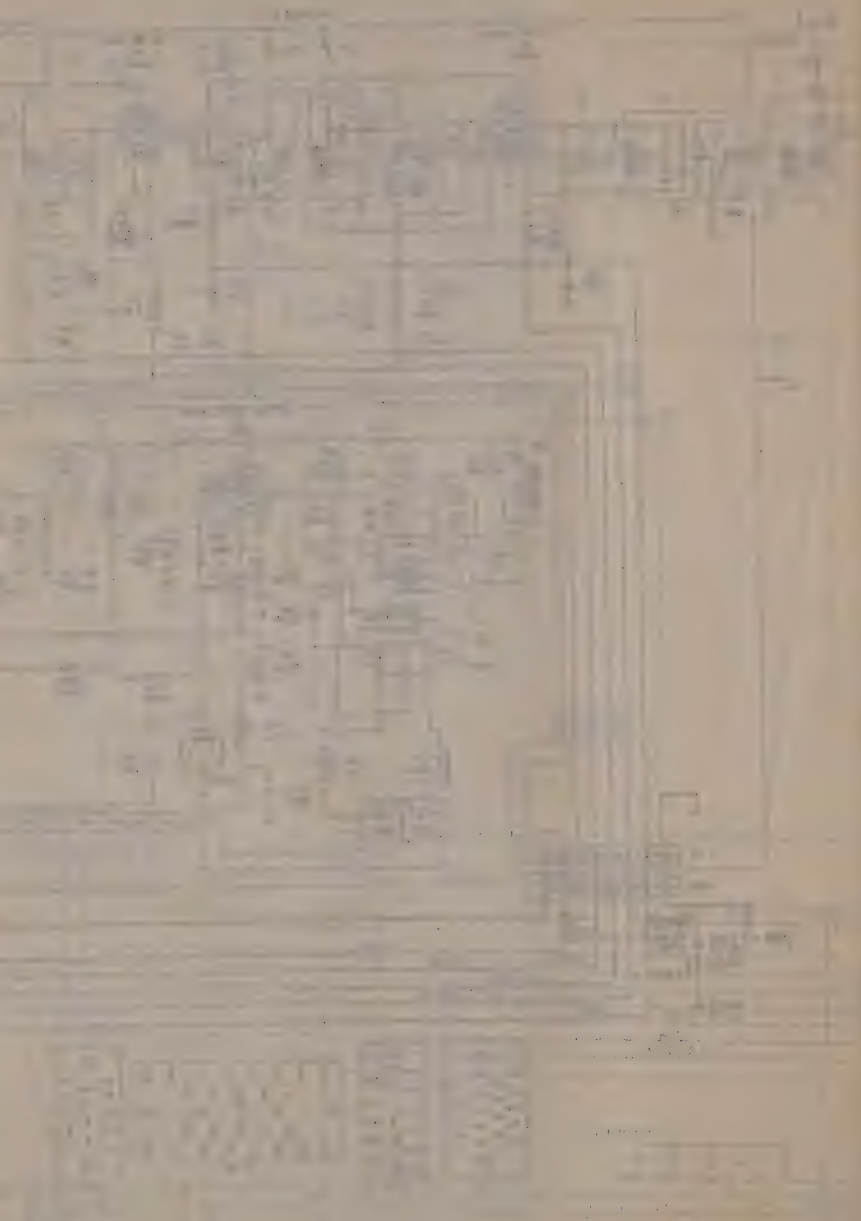
Figure 78. Radio Receiver R-394/U, schematic diagram.

NOTES

1. UNLESS OTHERWISE SHOWN, RESISTORS ARE IN OHMS, CAPACITORS ARE IN UUF.
2. CAPACITORS C28 THROUGH C31 ARE SMALL BRASS TABS MOUNTED BELOW THE PLUG-IN UNIT CHASSIS.
3. CAPACITORS C65, C66, AND C67 HAVE A NEGATIVE TEMPERATURE COEFFICIENT.
4. PLACE JUMPER BETWEEN TERMINALS 10 AND 11 OF TB 251 WHEN IT IS DESIRABLE TO USE THE SQUELCH RELAY UNIT.
5. GRD 1, GRD 2, GRD 3, AND GRD 4 SPECIFIC GRD IN RECEIVER BASE.
6. JUMPER CONNECTION BETWEEN TERMINALS 7 AND 8 OF TB 251 USED FOR OPERATION WITH POWER SUPPLY PP-846/U.
7. ON ALL EQUIPMENTS EXCEPT THOSE WITH AUDIO & SQUELCH PLUG-IN UNITS ON ORDER NO 11661-PHILA-52 WITH SERIAL NUMBERS BELOW 1214, THE FOLLOWING DIFFERENCES EXIST:
   - (a) R150 AND THE LEADS CONNECTING IT FROM THE 150-VOLT LINE TO PIN 2 OF V125 ARE DELETED
   - (b) PIN 2 OF V124 IS CONNECTED TO PIN 2 OF V125.
   - (c) THE VALUE OF C129 IS 47 UUF
   - (d) THE VALUE OF R131 IS 470K
   - (e) THE VALUE OF R132 IS 68K.
   - (f) THE VALUE OF R136 IS 330K
   - (g) THE VALUE OF R137 IS 560K
   - (h) THE VALUE OF R142 IS 330K
   - (i) THE VALUE OF R147 IS 120K
   - (j) THE VALUE OF R149 IS 220K
8. FILTER FL81 IS REPLACED BY C111 (1500UUF), R115 (47K), AND C112 (100 UUF) (READING FROM LEFT TO RIGHT) IN ALL 2ND IF DISCR PLUG-IN UNITS EXCEPT THOSE ON ORDER NO 11661-PHILA-52 WITH SERIAL NUMBERS BELOW 555!

TM 5092-610

344215 O - 55 (Faces p. 94)



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[AG 413.44 (18 Aug 54)]

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